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100 MHz Oscilloscope with Dual delayed timebase and event counter

PM 3263

Instruction Manual/Gerätehandbuch/Notice d'emploi et d'entretien

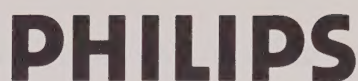
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C 2018

X1

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C 2035

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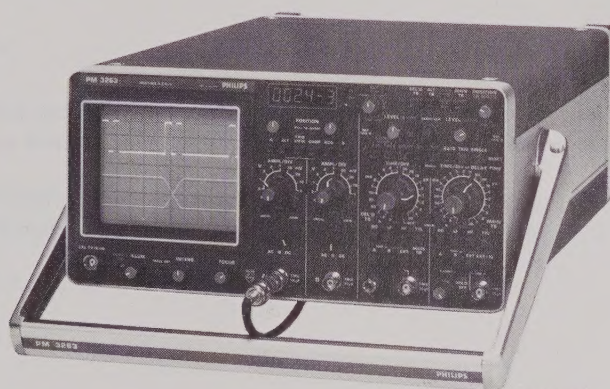
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IMPORTANT

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

NOTE: *The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.*

WICHTIG

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Leistungsschild.

BEMERKUNG: *Die Konstruktion und Schaltung dieses Geräts wird ständig weiterentwickelt und verbessert. Deswegen kann dieses Gerät von den in dieser Anleitung stehenden Angaben abweichen.*

IMPORTANT

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

REMARQUES: *Cet appareil est l'objet de développements et améliorations continus. En conséquence, certains détails mineurs peuvent différer des informations données dans la présente notice d'emploi et d'entretien.*

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Operating manual

1. GENERAL INFORMATION

1.1. INTRODUCTION

The PM 3263 is a two channel, portable, high sensitivity, wide band oscilloscope, with micro-processor controlled timing facilities.

These facilities include:

- Dual delayed time-base
- Event count triggering for both main- and delayed time base
- Frequency measurements

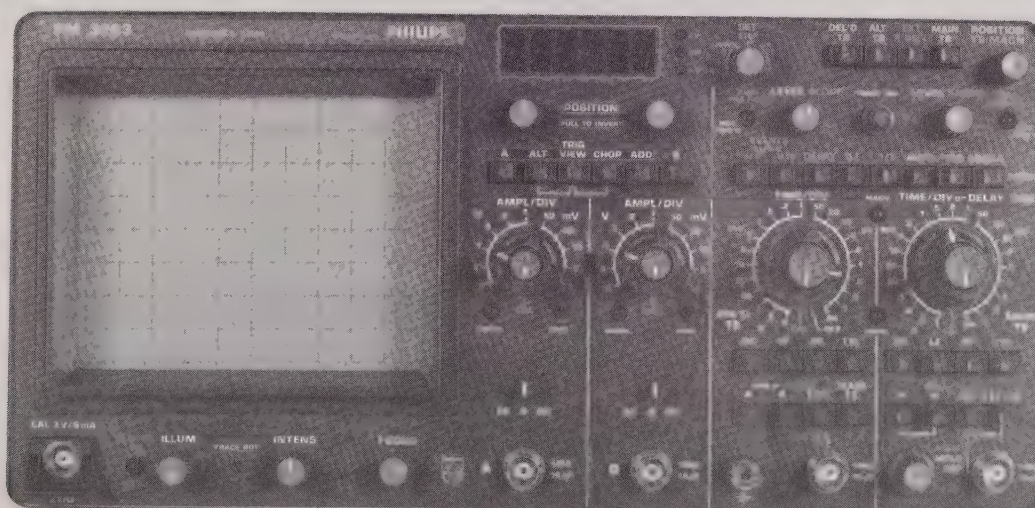
Time- and frequency measurement-results, and the selected number of events to be counted, are displayed in a 6-digit LED display. More-over the LED display shows ERROR or UNCAL messages in case of operator's errors.

Further facilities are: Trigger view, Alternate time-base display and Automatic TTL triggering.

Alternate time-base offers a simultaneous display of a signal on two different time-base scales provided by main time-base and delayed time-base.

The oscilloscope is provided with many integrated circuits which guarantee stable operation and reduce the number of adjusting points.

The supply voltage can be set to two ranges, 90 V to 140 V and 180 V to 265 V by means of a switch. All these features make the oscilloscope suitable for a wide range of applications.



MAT 196

Fig. 1.0. Front view PM3263

1.2. CHARACTERISTICS

This instrument has been designed and tested in accordance with IEC Publication 348 for Class I instruments and has been supplied in a safe condition. The present Instruction Manual contains information and warnings that shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition.

- This specification is valid after the instrument has warmed up for 30 minutes (reference temperature 23°C).
- Properties expressed in numerical values with tolerance stated, are guaranteed by the manufacturer.
Numerical values without tolerances are typical and represent the characteristics of an average instrument.
- Inaccuracies (absolute or in %) relate to the indicated reference value.

Designation	Specification	Additional Information
1.2.1. C.R.T.		
— Type	PHILIPS D14-302 GH/95	Rectangular tube face, domed mesh type, post-accelerator, metal-backed phosphor
Measuring area	80 x 100 mm	
— Screen type	P31 (GH) phosphor	P7 (GM) or P11 (BE) phosphor optional
Photographic writing speed	1500 cm/μs	Typically 2000 cm/μs Measured with Steinheil Oscillophot M5 camera; aperture: 1:1,2 object-to-image ratio 1:0,5 film: Polaroid 410 (10.000 ASA) No pre-fogging Phosphor type P31 (GH)
Total acceleration	17 kV	
Graticule	Internal	Continuously variable illumination
Engravings:	Centimetre divisions with sub-divisions of 2 mm along the central axes. Dotted lines at 1,5 and 6,5 div. from top of display provide measuring lattice for checking rise-time.	
— Trace rotation	Screw-driver adjustment available on front panel.	
1.2.2. Vertical or Y-deflection		
— Response (2 mV range excepted)		
Frequency range	d.c. to 100 MHz a.c. 10 Hz to 100 MHz	—3 dB upper bandwidth limit —3 dB Frequency range includes 10:1 probe over 20-30 °C
Rise-time	3,5 ns (see fig. 1.2B)	Over 6 divisions, +5 - +40 °C
Pulse aberrations	± 3 % peak-peak	
For 2 mV/DIV spec. refer to end of section 1.2.2.		
— Deflection coefficient	2 mV/div. ... 5 V/div.	Eleven calibrated positions in 1-2-5 sequence. Uncalibrated continuous control 1:≥2,5. Uncal. lamp signalling.
Accuracy	± 3 %	

Designation	Specification	Additional Information
— Maximum permissible input voltage	$\pm 400 \text{ V}$	d.c. + a.c. peak. Derating at frequencies above 500 kHz. See Fig. 1.3.
Maximum undistorted deflection	24 divisions	Up to 35 MHz
Shift range	16 divisions	8 divisions each in upward and downward direction from the central horizontal line of graticule.
— Input impedance	1 Megohm $\pm 2 \%$ /15 pF approx.	Input A and B equally adjusted
Input RC time	22 ms	AC input coupling
Trace stability	0,1 div./hour	+20 – +40 °C temperature range
Trace jump	0,2 div.	When switching between any of the attenuator positions.
Trace jump	0,5 div.	When operating the NORM/INVERT switch.
Trace shift	0,2 div.	When rotating the continuous attenuator. 0,4 div. in 5 mV/DIV setting.
Trace shift	1 div.	When switching to the ADDED position. 0,4 div. in 5 mV setting. Increasing when rotating the continuous attenuator.
Long-term temperature drift	$< 20 \mu\text{V}/^\circ\text{C}$	Typical value measured at 2 mV over 4 div.'s.
— Visible signal delay	15 ns approx.	
— Display modes	Channel + or – A only Channel + or – B only Trig. view only Channels $\pm$ A and $\pm$ B chopped Channels $\pm$ A and $\pm$ B alternated Channels $\pm$ A and $\pm$ B added $\pm$ A, $\pm$ B and Trig. view chopped or alternated (3 channels display)	If Trig. view display is selected in combination with alternate time-base display, this will be automatically displayed in main time-base intensified mode. Refer also to Fig. 1.6.
— Chopper frequency	1 MHz	Display time per channel 350 ns approx.
— Cross-talk between channels	1:500	Up to 50 MHz
— Common mode rejection factor	Better than 100 up to 2 MHz 20 at 50 MHz	Measured with +A and –B added Max. common-mode signal 8 divisions.
— Trigger view		
Display	External or internal signal	
Frequency response	$\geq 80 \text{ MHz}$	
Deflection coeff.	Same as vertical	
External	100 mV/div. $\pm 3 \%$	

Designation	Specification	Additional Information
External ÷ 10	1 V/div. ± 5 %	
Internal	Vertical ± 10 %	
Trigger point	Screen centre ± 0,3 div.	Coupling d.c.
Aberrations	± 10 % peak-to-peak	
Time delay between vertical input and external input	3 ns ± 1 ns	
— Specification of 2 mV/DIV setting		
Deflection coefficient	2 mV/Div.	
Error limit	± 5 %	
Frequency range	DC 0 - 35 MHz AC 7 Hz - 35 MHz	−3 dB upper bandwidth limit −3 dB
Rise-time	10 ns	
Pulse aberration	± 5 % peak-to-peak	
Common mode rejection factor	Better than 100 up to 2 MHz	
Trace stability	0,25 div./hour	+20 - +40 °C temperature range
Trace jump	1 div.	When switching between 2 mV/DIV. and 5 mV/DIV.
Trace jump	2 div.	When operating the NORMAL/INVERT switch.
Trace shift	1 div.	When rotating the continuous attenuator.
Trace shift	1 div.	When switching to ADDED position.

1.2.3. Horizontal or X-deflection

— Display modes	— Main time-base	
	— Main time-base intensified by delayed time-base	
	— Delayed time-base	
	— Main TB intensified and delayed TB alternately displayed	With possibility of trace separation of 4 divisions
	— X-Y and X-Y/Y operation	X deflection by: — Channel A signal — Channel B signal — Signal applied to EXT connector of main TB — Line voltage

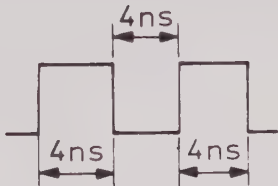
For dual-delayed time base and event-counting refer to section 1.2.6.

— Horizontal position drift in x1 position	0,2 div./hour	The horizontal position drift with the magnifier in the x1 position, shall not exceed 0.1 div./hour over +20-+40 °C temperature range. The same stability requirement applies to the start of the sweep during variation of the sweep speed setting, with exception of highest sweep ranges (50-100 ns/div.).
— Horizontal position control	± 5,2 div. from screen centre	The horizontal shift control combines coarse and fine adjustment.

Designation	Specification	Additional Information
1.2.4. Main Time-base		
— Operation	Automatic	Automatic free running in the absence of triggering signals, after less than 0,1 sec.
	Triggered Single sweep	
Sweeptime coefficients	1 s/div. ... 50 ns/div.	23 calibrated position in a 1-2-5 sequence. Uncalibrated continuous control 1:≥2,5 between steps. One uncal. lamp for both MTB and DTB.
— Coefficient error	± 2 % ± 3 %	+20 °C ... +30 °C + 5 °C ... +40 °C The difference in sweep accuracy over any two divisions of 10 div. sweep is ± 5 %, excluding the first and last div. at the 5 ns and 10 ns magnified sweep rates.
— Variable hold-off	The sweep hold-off time can be increased by a factor of 10.	The hold-off time is minimal if knob fully clock-wise (CAL). The knob is combined with X AMPL control.
— Expansion	10x	Switched, calibrated. The display section, which coincides with the central horizontal graticule line shall not shift more than one div. when the horizontal magnifier is changed from x1 to x10.
Coefficient error	± 1 % additional	First and last 50 ns of 5 ns/div., 10 ns/div. and 20 ns/div. magnified sweep rates ± 5 %.
Max. effective time coefficient	5 ns/div.	
1.2.5. Delayed time-base		
— Operation	Normal Dual	Started by MAIN TB or, Triggered. Started by MAIN TB.
— Sweeptime coefficient	0,5 s/div. ... 50 ns/div.	22 calibrated positions in 1-2-5 sequence. Uncalibrated continuous control 1:≥2,5 between the steps. One uncal. lamp for both MTB and DTB.
Coefficient error	± 2 % ± 3 %	+20 °C ... +30 °C + 5 °C ... +40 °C Difference in sweep accuracy over any two divisions of 10 div. sweep is ± 5 %, excluding the first and last div. at the 5 ns and 10 ns magnified sweep rates.
— Expansion	Identical to main time-base specification.	

Designation	Specification	Additional Information												
1.2.6. Delay Modes														
— Delay	Delayed time-base starts immediately after the delay time.	LED display shows delay time.												
	or Delayed time-base triggers after delay time.	LED display shows UNCAL 1												
— ΔT (interval)	Delayed time-base starts after Delay time and after Delay + ΔT time.	LED display shows ΔT time interval.												
1/T	ΔT or delay time inverted	LED display shows the frequency of a signal if ΔT , or Delay time coincides with one period of that signal.												
— Events before DTB	Delayed time-base is triggered after counting a number of events	LED display shows selected number of events.												
— Events before MTB	Main time-base is triggered after counting a number of events.	LED display shows selected number of events.												
— Events before MTB combined with delay, ΔT or 1/T	Main time-base is triggered after counting a number of events.	LED display shows the value belonging to the last selected function. Previous functions and values are stored in the memory. Triggering of delayed time-base not possible.												
Delay, ΔT , 1/T	Variable between 0X and 10X the time coefficient of the MTB	LED display shows a time, by 4 (or 3) digits with exponent, or if MTB continuous control is not in CAL position a number of divisions. If DTB is triggered LED display shows UNCAL 1.												
Resolution	$5 \cdot 10^{-4}$ of 10X main time-base setting.	MTB sweep in CAL position. In UNCAL position resolution is 0,05 mm.												
Jitter	1:30.000													
Accuracy	<table><tr><th>Delay</th><th>ΔT</th><th>1/T</th></tr><tr><td>$\pm 1\%$ of range</td><td>$\pm 1\%$ of reading</td><td>$\pm 1\%$ of reading</td></tr><tr><td>— A ‰ of range</td><td>— A ‰ of range</td><td>— A ‰ of range*</td></tr><tr><td>+ initial delay of 20 ns</td><td>$\pm 0,25\text{ ‰}$ of range</td><td>$\pm 0,25\text{ ‰}$ of range</td></tr></table>		Delay	ΔT	1/T	$\pm 1\%$ of range	$\pm 1\%$ of reading	$\pm 1\%$ of reading	— A ‰ of range	— A ‰ of range	— A ‰ of range*	+ initial delay of 20 ns	$\pm 0,25\text{ ‰}$ of range	$\pm 0,25\text{ ‰}$ of range
Delay	ΔT	1/T												
$\pm 1\%$ of range	$\pm 1\%$ of reading	$\pm 1\%$ of reading												
— A ‰ of range	— A ‰ of range	— A ‰ of range*												
+ initial delay of 20 ns	$\pm 0,25\text{ ‰}$ of range	$\pm 0,25\text{ ‰}$ of range												
	* A depends on main time-base setting A = 1,5 in settings starting at 5 A = 0,5 in settings starting at 1 A = 0 in settings starting at 2													
	Additional error in main time-base positions 50 ns/div. and 100 ns/div. resp. $\pm 3\%$ and $\pm 1\%$.													
Long term stability	< 2 div. at 1000x	Ratio between MTB and DTB sweep-time 1000.												

Designation	Specification	Additional Information
ΔT	Variable between 0x and 10x the time coeff. of the MTB	Time difference ΔT between the delayed sweeps is displayed, indicated by 4 (or 3) digits + ten's exponent. ΔT is read in sec. or if the MTB is out of calibrated position, in Div.'s. If the DTB is triggered LED display shows UNCAL 1. The second delayed sweep can never be set before the first delayed sweep. If a time interval is set and the setting of the first delayed sweep is changed (after release of the ΔT-button) the time interval is stored in the memory even if this interval is beyond the limit of the MTB The stored time interval is called back by pressing the ΔT button. The indication of the LED display will under no circumstances be higher than the difference between 10x the MTB setting and the delay of the first delayed time-base.
1/T	The LED display shows the inverted value of Delay time or ΔT time. Minimum distance between the markers: 0,1 div. 1 div.	1/T is read in Hz and indicated by 4 (or 3) digits and ten's exponent. If the MTB continuous control is not in CAL position the LED display shows UNCAL 3. x1 magn. x10 on. If the distance is too small the LED display shows UNCAL 2.
Events before DTB	Number of events can be set between 0 and 99999.	Number of events is continuously controllable by the SET potentiometer. Display counter speed is proportional to angle of rotation of potmeter and variable between 1 and 50 pulses per second and, in pushed position between 100 and 5000 pulses per second. If number of pulses set by the potentiometer is greater than the number of pulses displayed on one MTB sweep, the NOT TRIG lamp of the DTB will glow up. If in the event mode trigger source MAIN TB has been selected the LED display will indicate this by showing ERROR.
Events before MTB	Number of events can be set between 0 and 99999 Events before MTB can be combined with Delay, ΔT or 1/T modes.	MTB triggering releases the counter while pulses to be counted are processed by the DTB triggering.

Designation	Specification	Additional Information
Pulse conditions	Max. event rate 125 MHz Min. pulse width 4 ns Min. pulse space 4 ns	 <i>Fig. 1.1. Max. event rate 125 MHz.</i>
Set up times	Refer to fig. 1.2A.	
1.2.7. X deflection via Y_A or Y_B		Uncalibrated continuous control 1:≥2,5.
— Deflection coefficient	2 mV/div. ... 5 V/div.	
Coefficient error	± 5 %	
Bandwidth	0-2 MHz	—3 dB bandwidth for 8 div.'s deflection. up to 0,1 MHz
Maximum undistorted deflection	20 divisions	
Phase difference with respect to Y display	3 °C at 0,1 MHz	
1.2.8. External X-deflection via EXT socket		
— Deflection coefficient		
External	50 mV/div.	Uncalibrated continuous control
External ÷ 1-	500 mV/div.	1:3 with x AMPL control. Calibrated in fully clockwise (CAL) position.
Input characteristics	Identical to Y inputs	
Accuracy	± 3 %	Additional 2 % for Ext. ÷ 10.
Bandwidth	DC ... 2 MHz —3 dB for 4 divisions deflection 7 Hz .. 2 MHz —3 dB for 4 divisions deflection	Via DC trigg. coupling Via LF or HF trig. coupling.
Phase difference w.r.t. Y-channels	3° at 0,1 MHz	
Linearity	1,5 %	
Drift	0,2 div./hr.	
1.2.9. Triggering of the Main Time-base		
Trigger source	Internal from channel A Internal from channel B Composite A and B Internal from line External External ÷ 10	Alternate vertical mode only.
Trigger modes	Automatic Triggered Single sweep	Automatic free-run of the time-base generator approx. 0,1 s after disappearance of the trigger signal.
Not trig'd lamp	Indicates the not triggered state of the main time base. In single sweep mode the lamp is on after main time-base reset, and extuingishes at the end of the sweep.	
Slope	+ Or —	

Designation	Specification	Additional Information
Trigger sensitivity	Internal: 0,5 div. up to 30 MHz 1,5 div. up to 100 MHz External: 50 mV up to 30 MHz 150 mV up to 100 MHz External ÷ 10: 500 mV up to 100 MHz	Typical sensitivity as a function of frequency, see Fig. 1.4. Typical sensitivity as a function of frequency, see Fig. 1.5.
Trigger modes and coupling	DC: full bandwidth LF int: 0-30 kHz LF ext: 7 Hz - 30 kHz HF: 30 kHz - 100 MHz TTL	Both internal and external -3 dB -3 dB -3 dB both internal and external Automatic TTL triggering Level control not functioning.
TTL levels	Internal triggering (A, B or Comp.) Low: 0,8 div. ($\pm 0,4$ div.) High: 2 div. ($\pm 0,4$ div.) Gap: 1,2 div. External triggering (EXT) Low: 0,8 V ($\pm 0,4$ V) High: +2 V ($\pm 0,4$ V) Gap: 1,2 V	These data apply to voltages on the tip of a 1:10 attenuator probe connected to the EXT input socket with trigger source selector in EXT position.
Level range	Internal trigg: 24 div. External trigg: +1,2 V to -1,2 V External ÷ 10: +12 V to -12 V	
Input impedance	Identical to Y inputs	
Trigger jitter	Better than 0,5 ns	

1.2.10. Triggering of the Delayed Time-base

Source	Internal from channel A Internal from channel B External Main TB	Other characteristics are identical to TRIGGERING OF THE MAIN-TIME BASE. Except Ext. ÷ 10 and line trigg.
Not trig'd lamp	Indicates the not-triggered state of the delayed time-base	

1.2.11. Calibration Output

Voltage	3 Vp-p	
Current	6 mA	Through current loop
Error limit	$\pm 1 \%$	Both voltage and current
Frequency	2 kHz $\pm 2 \%$	
Protection	The output is protected against continuous short-circuiting.	

Designation	Specification	Additional Information
1.2.12. Additional Input and Outputs		
Z-Modulation input	DC coupled TTL compatible response time 35 ns. input impedance 10 kΩ max. input voltage 50 V	Logic high blanks out the display
Main TB Gate output	+5 V during MTB sweep, otherwise "0" V.	Output impedance 1 KOhm.
Delayed TB Gate output	+5 V during DTB sweep, otherwise "0" V.	Output impedance 1 KOhm.
1.2.13. Power Supply		
Line voltage	100-127 Va.c. ± 10 % 220-240 Va.c. ± 10 % 250 Vd.c. - 350 V d.c.	Automatically protected against incorrect setting of line voltage selector. Line voltage selector in either position.
Line frequency	46 to 440 Hz	
Power consumption	60 W	
Build-in line fuse	2 Amps. delayed action	Located on rear panel.
Power transients	Damage to the oscilloscope shall not occur under voltage and frequency transient conditions specified in MIL-T-28800.	

1.2.14. Environmental Characteristics

The characteristics are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS-organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, THE NETHERLANDS.

- *Temperature tests*
In accordance with IEC 68 Ab and Bb.
Operation: -15 °C to +55 °C.
Operation within specification: +5 °C to +40 °C. Exceptions on tolerances to be indicated per spec. point.
Storage: -40°C to +70°C, tested from -55°C to +75°C
- *Altitude*
In accordance with IEC 68-2-13 test M.
Operation: to 15.000 feet (5000 m.)
Derating: 1°C/1000 feet for the max. operating temperature.
Storage: to 50.000 feet (17.000 m.)
- *Humidity*
In accordance with IEC 68 Db following the standard Philips oscilloscope test program; also comparison with MIL-E-1640F 5 cycles (120 hours) has to be made.

Designation	Specification	Additional Information
— <i>Shock</i>	Operating: 30 g, half-sine, 11 ms duration, 2 shocks per axis per direction for a total of 12 shocks.	
— <i>Vibration</i>	Operating: 15 minutes along each of 3 axes. 0,025 inch p-p displacement (4 g at 55 Hz) with frequency varied from 10 Hz to 55 Hz, in one minute cycles.	
— <i>Recovery</i>	Operates within 30 minutes of being brought from -10°C soak, into room condition of 60 % R.H. at 20°C .	
— <i>Magnetic Shielding</i>	In accordance with IEC 351-22.3.1. A maximum deviation of 1 div.	
— <i>Interference</i>	VDE 0871 and 0875, störgrad K.	

1.2.15. Mechanical Data

— Dimensions	Length 460 mm. (18 1/8 inch) Width 316 mm. (12 1/4 inch) Height 154 mm. (6 1/8 inch)	Excluding controls, cover and feet.
— Weight	10,7 kg (23 1/2 lbs)	

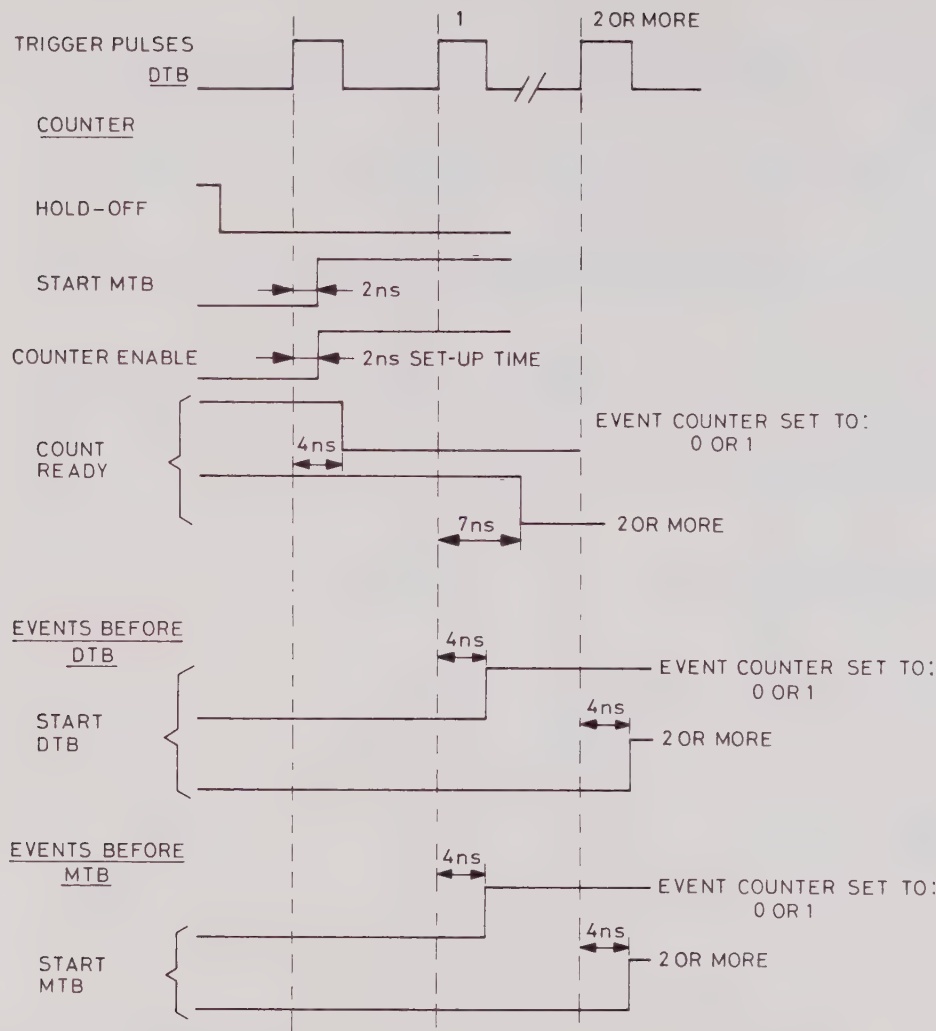
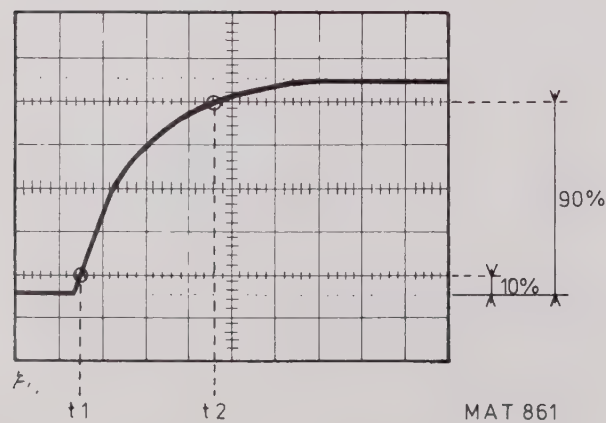


Fig. 1.2A Set up times

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Fig. 1.2B Rise time measurement $t_R = t_2 (90\%) - t_1 (10\%)$

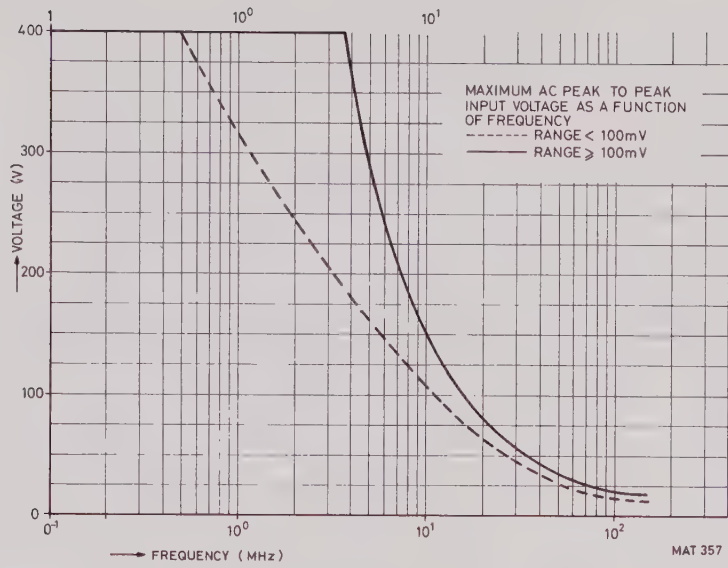


Fig. 1.3. Derating of the maximum permissible input voltage as a function of frequency

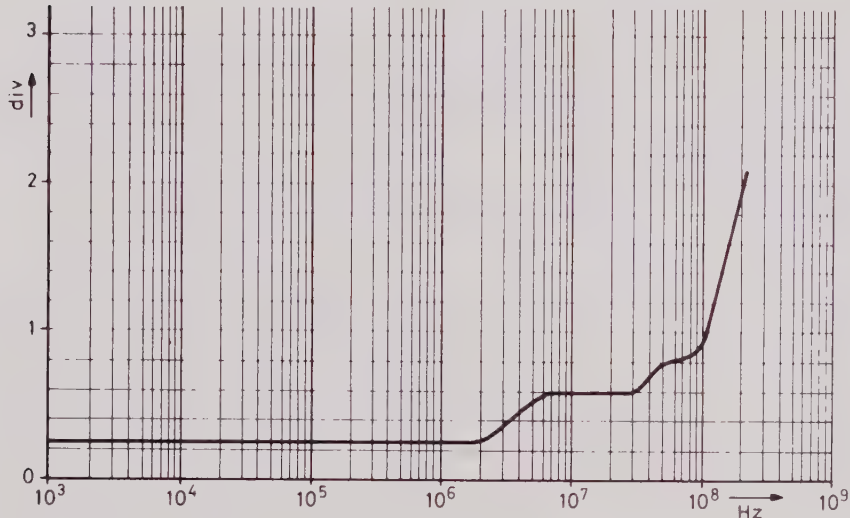


Fig. 1.4. Typical trigger sensitivity internal as a function of frequency

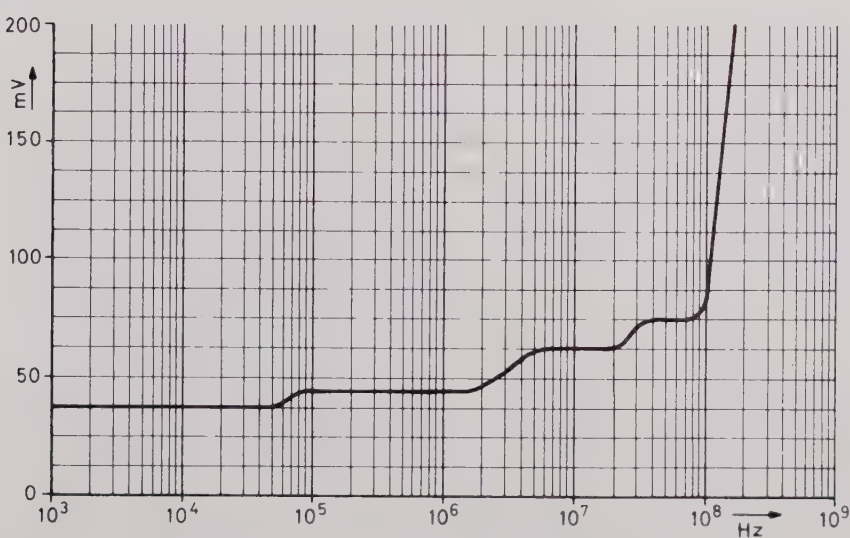
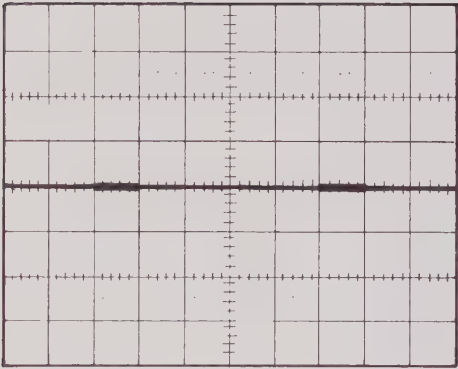
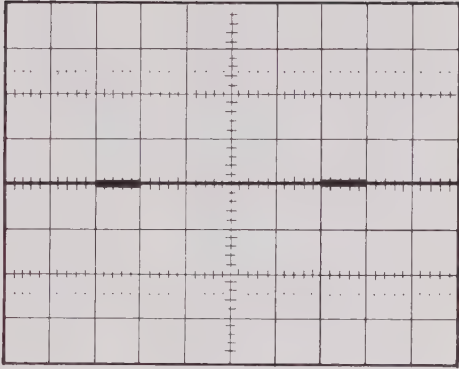


Fig. 1.5. Typical trigger sensitivity external as a function of frequency



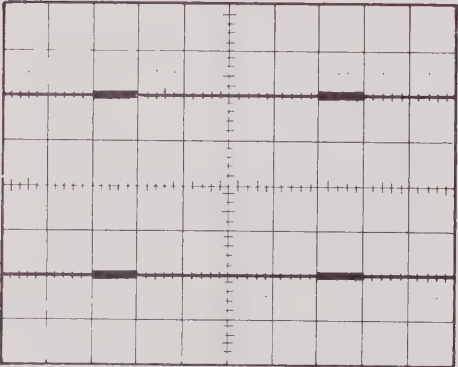
ch. A or ch. B only MA9992

1) Ch. A or ch. B only



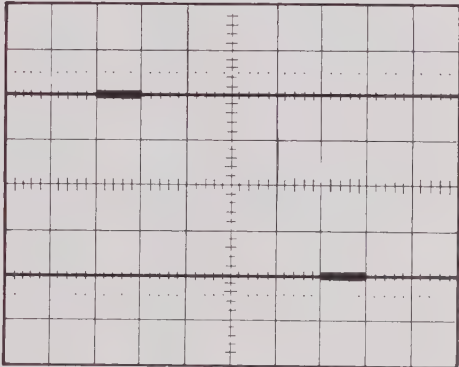
ch. A and ch. B added MA9993

2) Ch. A and ch. B added



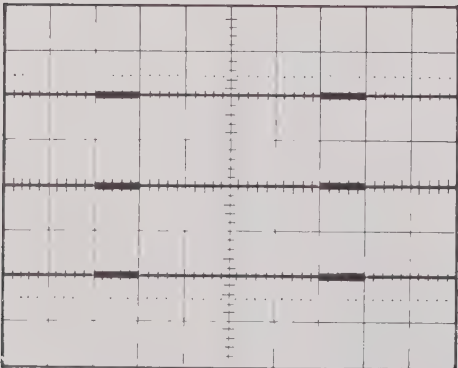
ch. A and ch. B chopped MA9994

3) Ch. A and ch. B chopped



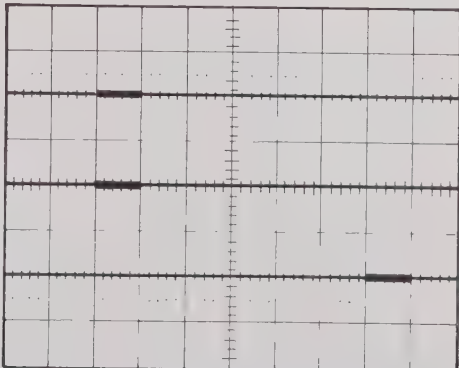
ch. A and ch. B alternated MA9995

4) Ch. A and ch. B alternated



Trigger view, and ch. A and ch. B chopped MA9996

5) Trigger view, and ch. A and ch. B chopped



Trigger view, and ch A and ch B alternated MA9997

6) Trigger view, and ch. A and B alternated

Fig. 1.6. Summary of display modes with dual delayed time-base

1.3. ACCESSORIES DELIVERED WITH THE INSTRUMENT

- Two passive 10:1 probes
- Contrast filter
- Front cover with storage space for e.g. probes
- Collapsible viewing hood PM 9366
- Banana/BNC adapter PM 9051
- Adaptor CAL terminal/BNC
- Manual

1.4. INFORMATION CONCERNING THE 10:1 PROBES DELIVERED WITH THE INSTRUMENT

This 10x attenuator probe is designed for real time oscilloscopes up to 250 MHz, having a BNC input jack and $13\text{pF} \pm 3\text{pF}$ input capacitance paralleled by $1\text{M}\Omega$.

1.4.1. Characteristics

Electrical

Attenuation

$10x \pm 2\%$ (Oscilloscope input $1\text{M}\Omega \pm 1\%$)

Input resistance d.c.
a.c.

$10\text{M}\Omega \pm 2\%$ (Oscilloscope input $1\text{M}\Omega \pm 5\%$)

See curve Fig. 1.7.

Input capacitance d.c. and l.f.

$11\text{pF} \pm 1\text{pF}$ (Oscilloscope input $1\text{M}\Omega \pm 5\%$ paralleled by $13\text{pF} \pm 3\text{pF}$)

Input reactance h.f.
bandwidth

See curve Fig. 1.7.

Probe has negligible effect on oscilloscope bandwidth

Max. input voltage

500V d.c. + a.c. peak, derating with frequency. See Fig. 1.8. Oscilloscope input $1\text{M}\Omega$ and voltage applied between probe tip and earthed part of probe body. Test voltage $1500\text{V}_{\text{d.c.}}$ during 1s. at a temperature between 15 and 25°C , a rel. hum. of 80% at maximum and at sea level.

Check-zero button probe shell

Same function as 0 position of input coupling switch on oscilloscope.

Environmental

Probe operates within specifications over the following ranges:

Temperature

-25°C to $+70^\circ\text{C}$

Altitude

Up to 5000 metres (15000 feet)

Other environmental data

Same as for any PHILIPS oscilloscope the probe is used with

Mechanical

Dimensions

Probe body 103mm x 10mm dia (max.)

Cable length 1500mm or 2500mm

Correction box 55 x 30 x 15mm incl. BNC

Incl. standard accessories 125 g.

Mass

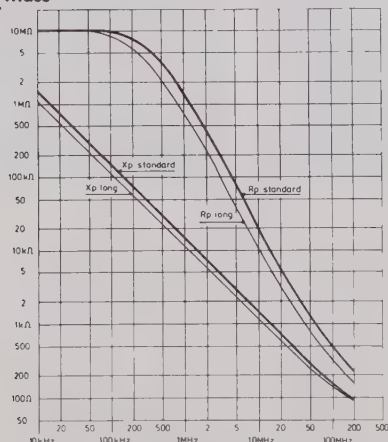


Fig. 1.7. Input resistance (R_p) and reactance (X_p) as a function of frequency

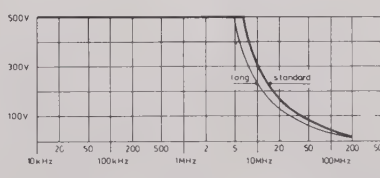


Fig. 1.8. Maximum AC component of input voltage as a function of frequency

1.4.2. Adjustments

Matching the probe to your oscilloscope

The measuring probe has been adjusted and checked by the manufacturer. However, to match the probe to your oscilloscope, the following manipulation is necessary.

Connect the measuring pin to the CAL socket of the oscilloscope.

A trimmer C2, can be adjusted through a hole in the compensation box to obtain optimum square-wave response. See Fig. 1.9. b.

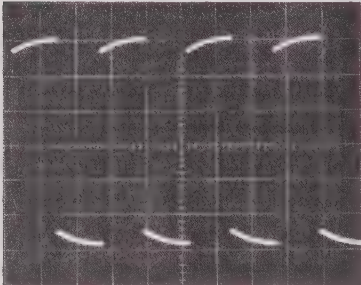


Fig. 1.9.a. Over-compensation (adjustment C2)

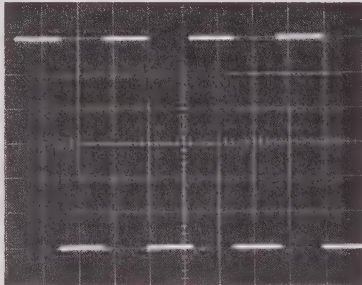


Fig. 1.9.b. Correct compensation (adjustment C2)

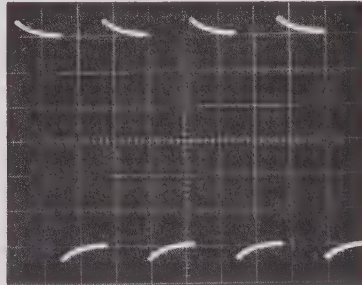


Fig. 1.9.c. Under-compensation (adjustment C2)

Adjusting the h.f. step response

The h.f. step response correction network has been adjusted by the manufacturer to match the oscilloscope input, so that adjustment of the h.f. response is normally not necessary.

Later readjustment is only necessary if the probe is to be used with a different type of oscilloscope, or after replacement of an electrical component.

For the adjustment, proceed as follows:

Connect the probe to a fast pulse generator (rise-time not exceeding 1 ns) which is terminated by its characteristic impedance. Dismantle the compensation box. Set the generator to 100kHz. Adjust C3, C4, R2, R4 and R5 alternatively to obtain a display as shown in Fig. 1.10.a.

It is important that the leading edge is as steep, and the top is as flat, as possible. Incorrect setting of C3, C4, R2, R4 and R5 give rise to pulse distortions as shown in Fig. 1.10.b. and 1.10.c.

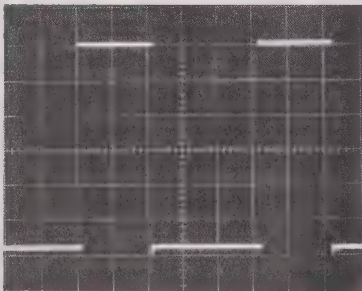


Fig. 1.10.a. Preset potentiometers correctly adjusted

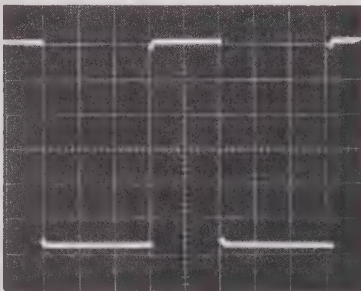


Fig. 1.10.b. Rounding due to incorrectly adjusted potentiometers

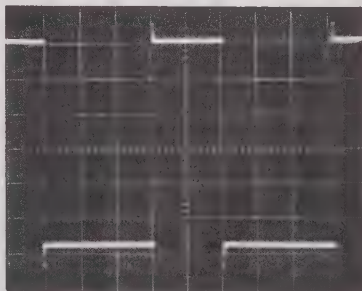


Fig. 1.10.c. Overshoot due to incorrectly adjusted potentiometers

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For the Location of adjustment points C3, C4, R2, R4 and R5 on the p.c.b. in the compensation box, refer to fig. 1.13.

1.4.3. Dismantling

Dismantling the probe (see Fig. 1.11.)

The front part 11 of the probe can be screwed from the rear part 13. Item 11 can then be slid from 12 and 13.

The RC combination 12 is soldered to 13. For replacement of 12 refer to the next section.

Dismantling the compensation box (see Fig. 1.11.)

Unscrew the ribbed collar of the compensation box to the cable. The case 14 can then be slide sideways off the compensation box. The electrical components on the printed-wiring board are then accessible.

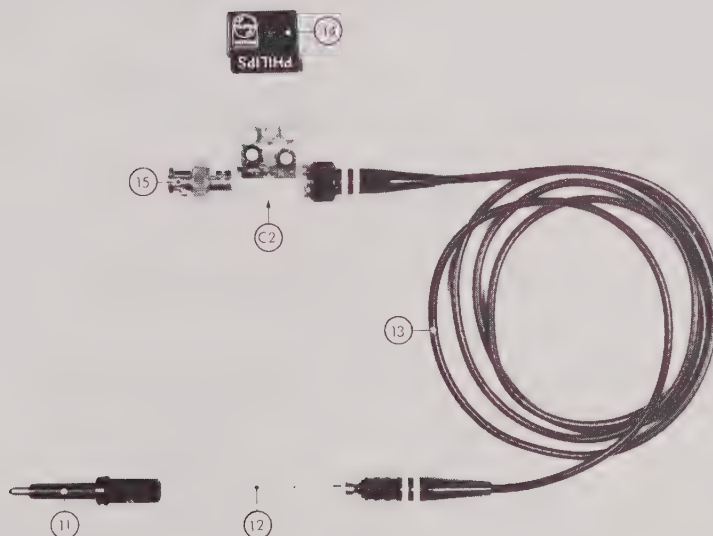


Fig. 1.11. Dismantling the probe

1.4.4. Replacing parts

Assembling the probe

A new RC network is slid over the cable nipple, after which the cable core is soldered on to the resistor wire. When the measuring probe is assembled, the RC network must be at dead centre in the probe tip.

Replacing the cable assembly

Dismantle the compensation box.

Unsolder the connection between the inner conductor and the printed-wiring board. Keep the frame of the compensation box steady and loosen the cable nipple with a 5 mm spanner on the hexagonal part. Replace the cable and fit it, working in the reverse order.

Replacing the BNC

Dismantle the compensation box.

Unsolder the connection to the printed-wiring board. Hold the frame of the compensation box firmly and loosen the BNC with a 3/8 inch spanner. Replace the BNC and fit it, working in the reverse order.

Replacing the probe tip

The damaged tip can be pulled out by means of a pair of pliers. A new tip must be firmly pushed in.

1.4.5. Parts list

1.4.5.1. Mechanical parts (see Fig. 1.11, and 1.12.)

Items 1 to 10 are standard accessories supplied with the probe.

Item	Order number	Qty	Description
1	5322 321 20223	1	Earth cable
2	5322 256 94136	1	Probe holder
3	5322 255 44026	5	Soldering terminals which may be incorporated in circuits as routine test points
4	5322 532 64223	2	Marking ring red
5	5322 532 64224	2	Marking ring white
	5322 532 64225	2	Marking ring blue (not shown)
6	5322 268 14017	2	Probe tip
7	5322 462 44319	1	Insulating cap to cover metal part of probe during measurements in densely wired circuits
8	5322 462 44318	2	Cap facilitating measurements on dual-in-line integrated circuits
9	5322 264 24018	1	Wrap pin adaptor
10	5322 264 24019	1	Spring-loaded test clip
11	5322 264 24021	1	Probe shell with check-zero button
12	5322 216 54152	1	RC network
13	5322 320 14063	1	Cable assembly
14	5322 447 64015	1	Cap
15	5322 268 44019	1	BNC connector

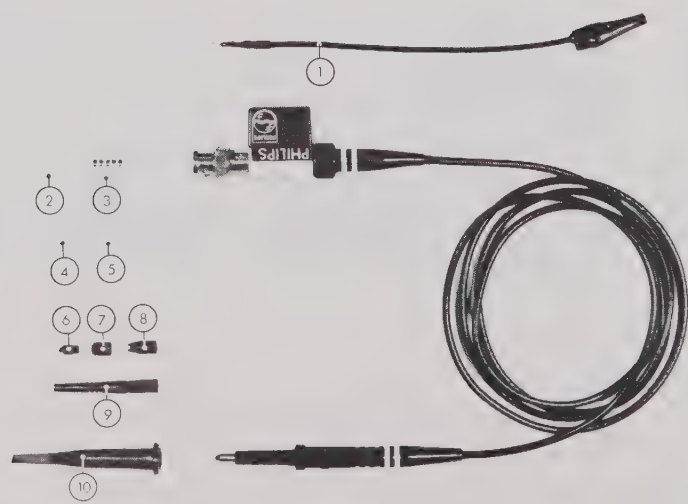


Fig. 1.12. Mechanical parts of the probe

1.4.5.2. Electrical parts (see Fig. 1.13.)

Item	Order number	Description
C1	—	Part of RC network (not supplied separately)
C2	5322 125 54003	Trimmer 60 pF, 300 V
C3	5322 125 50048	Trimmer 3,5 pF, 300 V
C4	5322 125 50051	Trimmer 18 pF, 300 V
L1	—	Coil (not supplied)
R1	—	Part of RC network (not supplied separately)
R2	5322 100 10135	Potmeter 470 Ω , 20%
R3	5322 116 50536	Metal film resistor 464 Ω , 1%, MR25
R4	5322 100 10135	Potmeter 470 Ω , 20%
R5	5322 100 10143	Potmeter 1 k Ω , 20%

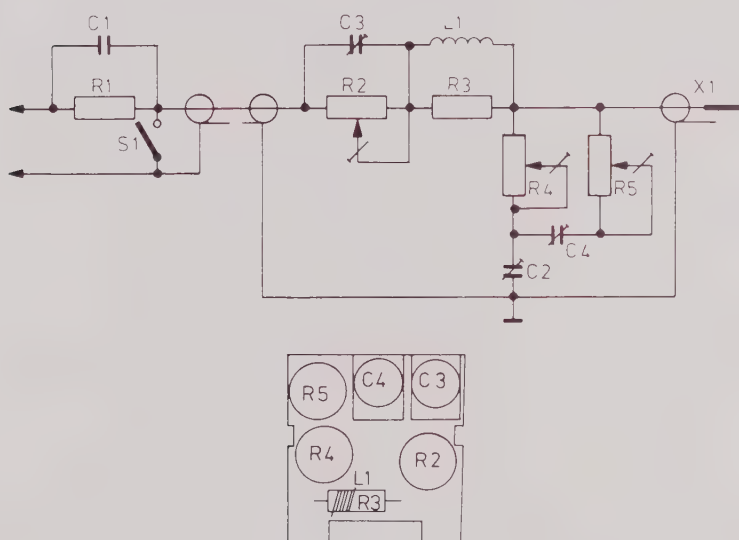


Fig. 1.13. Electrical parts and p.c.b. lay-out of the probe

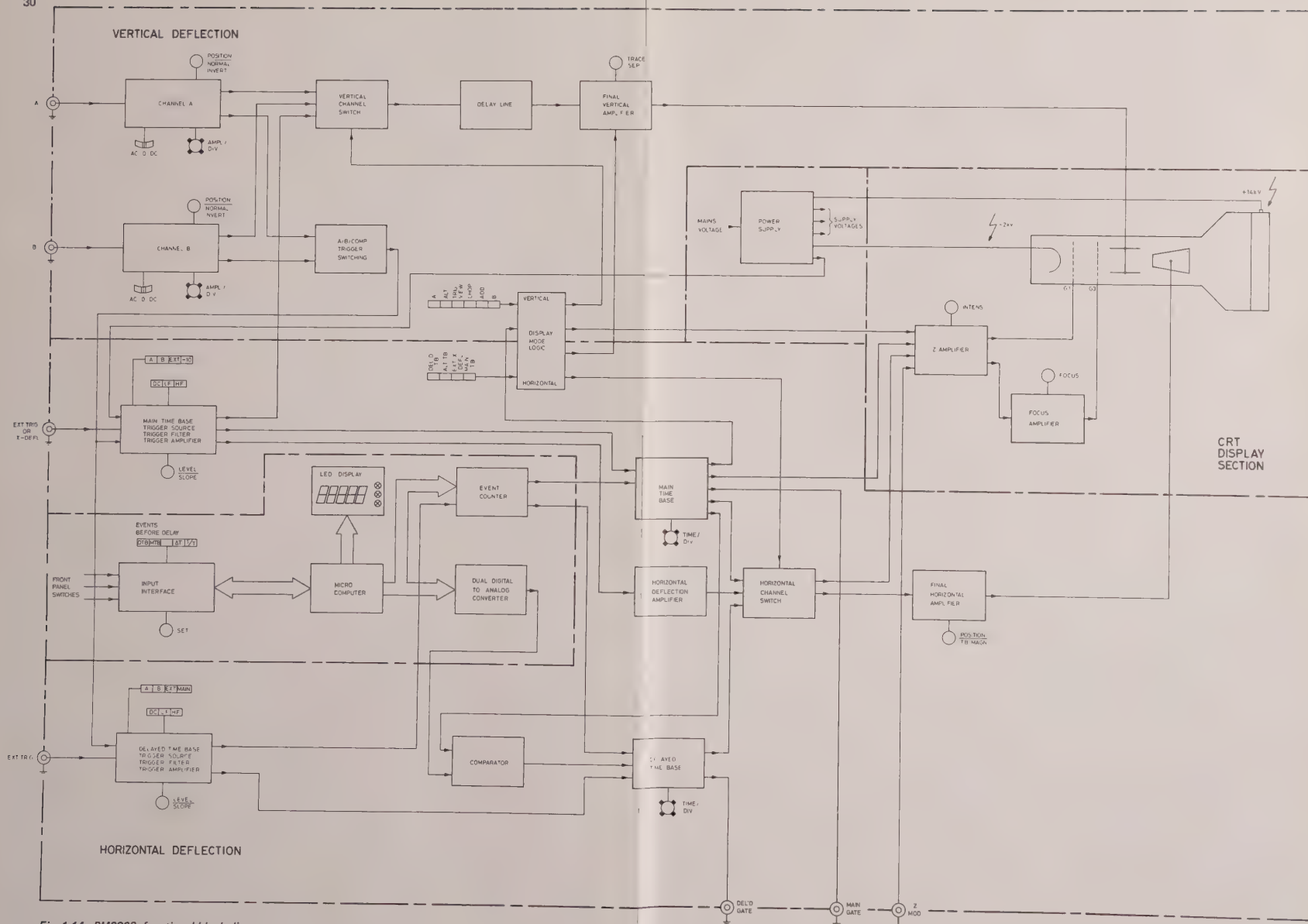


Fig. 1.14. PM3263, functional block diagram
 Abb. 1.14. PM3263, funktionelles Blockschaltbild
 Fig. 1.14. PM3263, schéma synoptique de fonctionnement

1.5. DESCRIPTION OF FUNCTIONAL BLOCK DIAGRAM

1.5.1. Vertical deflection

The instrument has two identical channels A and B, each providing signal control and amplification for respectively the A and B input. For simplicity, only channel A is described.

CHANNEL A incorporates an AC/0/DC signal coupling switch, an AMPL/DIV control for adjusting the signal amplification to give the desired vertical trace height, and a POSITION control which also combines the NORMAL/INVERT function. In the three positions of the AC/0/DC switch the input signal is respectively applied to the amplifier input via a DC blocking capacitor (AC position), the input signal is interrupted (0-position) or the signal is directly coupled to the amplifier input (DC position). The POSITION potentiometer provides continuous rotary control of the vertical shift of the signal on the screen; the push-pull control action enables the signal to be displayed either in the NORMAL or in the INVERTED polarity mode.

Time base triggering on a signal derived from one of the vertical channels is possible via the block A/B/COMPOSITE TRIGGER SWITCHING.

The VERTICAL CHANNEL SWITCH is able to switch the CHANNEL A output signal through to the DELAY LINE and FINAL VERTICAL AMPLIFIER or to block this signal. Other signal sources for DELAY LINE and FINAL VERTICAL AMPLIFIER are the CHANNEL B output signal or the TRIGGER VIEW signal. This signal is the signal on which the main time base triggers and its originates from the main time base trigger source. If CHANNEL A and B are switched through simultaneously, the output signals of these channels are added and the sum is displayed on the screen. The VERTICAL CHANNEL SWITCH is controlled by the VERTICAL DISPLAY MODE LOGIC that is operated by the vertical display mode switch A, ALT, TRIG VIEW, CHOP, ADD, B. If more than one channel is displayed the display can function in the CHOPPED or the ALTERNATE display mode. A signal derived from the MAIN TIME BASE is used for the ALTERNATE display mode switching.

The DELAY LINE gives the necessary signal delay to enable the leading edge of a fast signal phenomenon to be displayed on the screen.

The FINAL VERTICAL AMPLIFIER drives the vertical deflection plates of the CRT. In the alternate time base mode the TRACE SEPARATION control enables an adjustable vertical trace shift between main and delayed time-base signals to facilitate comparison.

1.5.2. Horizontal deflection

Choice of input source for the FINAL HORIZONTAL AMPLIFIER can be selected from the MAIN TIME BASE, the DELAYED TIME BASE and the HORIZONTAL DEFLECTION AMPLIFIER.

Source selection is done by the HORIZONTAL CHANNEL SWITCH that is controlled by the HORIZONTAL DISPLAY MODE LOGIC. This logic is operated by the vertical display mode switch DELD TB, ALT TB, EXT X DEFL, MAIN TB.

Both the MAIN TIME BASE and the DELAYED TIME BASE can generate a time-linear sawtooth voltage, the sweep time of which is adjustable by a TIME/DIV control.

MAIN TIME BASE TRIGGER SOURCE/FILTER/TRIGGER AMPLIFIER:

the main time base can be triggered by channel A or B, a mains voltage related signal originating from the power supply or by a signal applied to the external trigger input EXT TRIG OR X DEFL. The desired trigger source can be selected by the trigger source switch. The selected source signal can be filtered by a LF filter, a HF filter or can be passed through unfiltered if the DC pushbutton of the DC/LF/HF switch is depressed. The level and the slope at which the main time base is started can be determined by the LEVEL/SLOPE control. The selected main time base trigger source can also be used for horizontal deflection via the HORIZONTAL DEFLECTION AMPLIFIER and for TRIGGER VIEW via the VERTICAL CHANNEL SWITCH.

If the EVENTS BEFORE MTB mode is selected the start of the MAIN TIME BASE is initiated by a signal from the EVENT COUNTER. See section 1.5.3.

DELAYED TIME BASE TRIGGER SOURCE/FILTER/TRIGGER AMPLIFIER: the delayed time base can be triggered by channel A or B or by a signal applied to the external trigger input EXT TRIG. The signal coupling DC/LF/HF and LEVEL/SLOPE are adjustable.

The block marked COMPARATOR compares the main time base sawtooth waveform with an adjustable DC voltage from the DUAL DIGITAL TO ANALOG CONVERTER. This happens in the DELAY and ΔT modes.

For details see section 1.5.3.

At the moment that the sawtooth voltage corresponds to the adjusted DC level the COMPARATOR sends a signal to the DELAYED TIME BASE. If pushbutton MAIN TB of the trigger source selector is depressed the DELAYED TIME BASE now starts immediately. If pushbutton A, B or EXT of the trigger source selector is depressed the DELAYED TIME BASE starts after the signal from the COMPARATOR upon receipt of a trigger pulse from the selected trigger source.

If the EVENTS BEFORE DTB mode is selected and pushbutton A, B or EXT of the delayed time base trigger source selector is depressed the start of the DELAYED TIME BASE is initiated by a signal from the EVENT COUNTER. See section 1.5.3.

1.5.3. Delay and event counter section

The heart of this section of the instrument is formed by the MICROCOMPUTER. This block scans sequential the settings of the front panel controls. This is done by means of the INPUT INTERFACE. Depending on the settings of these controls the computer can activate a number of blocks that are connected to it.

First of all the computer sets the LED DISPLAY to the value and function selected by the front-panel controls. If these controls occupy an incorrect position the display will also indicate this.

In the DELAY mode the computer controls the DUAL DIGITAL TO ANALOG CONVERTER. This converter produces an output DC voltage that is applied to the COMPARATOR described in section 1.5.2. The computer controls the converter in such a way that the DELAY value represented in the display corresponds with the real delay between start of main and delayed time base.

In the DELAY and ΔT mode the comparator receives alternately two different DC voltages from the convertor:

- One main time base sweep a DC-voltage is applied to the comparator giving a delayed time base start after the adjusted DELAY time.
- The next main time base sweep a somewhat higher DC-voltage is applied to the comparator giving a delayed time base start after the $\text{DELAY} + \Delta T$ time.

The display now shows the value for the ΔT time. If the pushbutton 1/T is depressed the computer calculates the value for $1/\Delta T$ and takes care that the display shows this value.

In the modes EVENTS BEFORE MTB or EVENTS BEFORE DTB the EVENT COUNTER is functioning. Now the number of events/pulses derived from the DELAYED TIME BASE TRIGGER SOURCE are counted by the EVENT COUNTER. If the selected number of events has been counted, the EVENT COUNTER starts the main time base (in EVENTS BEFORE MTB mode) or it starts the delayed time base (in EVENTS BEFORE DTB mode). The MICROCOMPUTER controls EVENT COUNTER and LED DISPLAY so that after the number of events represented in the display the main or delayed time base starts.

1.5.4. CRT display section

The Z AMPLIFIER receives five input signals that determine the intensity of the spot on the screen.

This intensity is controlled via the "Wehnelt Cylinder" G1 of the cathode ray tube (CRT).

Together with the intensity also the focusing of the spot on the screen is corrected. As a result the focusing of the spot on the screen does not change due to variation of intensity.

The signals that control spot intensity and focusing are:

- The setting of the front panel INTENS control.
- A blanking signal: for the chopped display mode originating from the VERTICAL DISPLAY MODE LOGIC.
- A signal for display blanking during the main time base hold off period originating from the MAIN TIME BASE.
- A signal originating from the HORIZONTAL CHANNEL SWITCH for the intensified part of the delayed time base signal on the main time base signal.
- An external signal that can be applied to the input socket Z-MOD.

1.5.5. Power Supply

The mains power supply is stabilised and produces the DC supply voltages for the electronic circuits in the instrument, the high positive voltage for the first accelerator of the CRT, the high negative voltage for the cathode of the CRT. More over the power supply supplies a mains voltage related signal for trigger purposes of the main time base.

2. INSTALLATION INSTRUCTIONS

2.1. IMPORTANT SAFETY INSTRUCTIONS (IN ACCORDANCE WITH IEC 348)

Before connecting the instrument to the mains (line), visually check the cabinet, controls and connectors etc. to ascertain whether any damage has occurred in transit. If any defects are apparent, **do not** connect the instrument to the mains (line).

CLAIMS: In the event of obvious damage or shortages, or if the safety of the instrument is suspect, a claim should be filed with the carrier immediately. A Philips Sales or Service organisation should also be notified in order to facilitate the repair procedure.

Before any other connection is made, the protective earth terminal shall be connected to a protective conductor (see section 2.4. EARTHING).

WARNING: The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals, which can be dangerous to life.

The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair is effected with the instrument open. If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the hazards involved. Bear in mind that the capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

2.2. REMOVING AND FITTING THE FRONT COVER (see fig. 2.1.)

Removing:

- Push and rotate the knob in the centre of the cover a quarter-turn anti-clockwise to the UNLOCKED position.
- Remove the cover.

Fitting:

- Push and rotate the knob to the UNLOCKED position.
- Fit the cover over the front of the oscilloscope.
- Press and rotate the knob a quarter-turn clockwise to the LOCKED position.

2.3. POSITION OF THE INSTRUMENT

The instrument may be used in any desired position. With the handle folded down the instrument may be used in sloping position. The electrical characteristics in accordance with chapter 1.2. are guaranteed for any position of the instrument. (Ensure that the ventilation holes in the top and bottom covers are free). Do not position the instrument on any surface which produces or radiates heat, or in direct sunlight. The carrying handle can be rotated if the push-buttons on its bearings are depressed.



Fig. 2.1. Removing the front cover

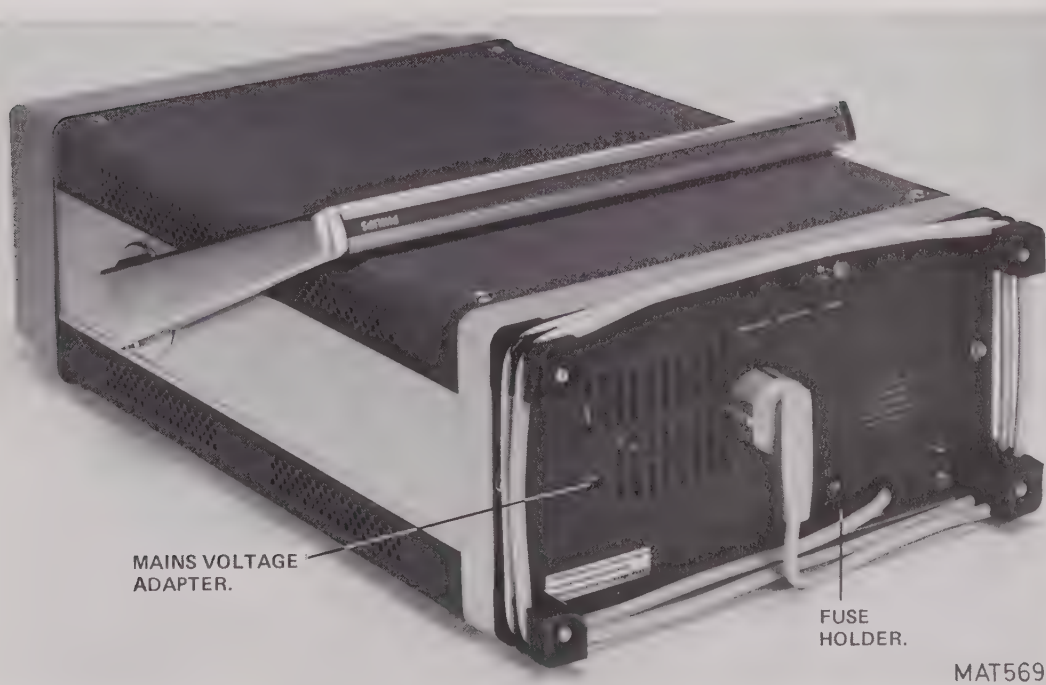


Fig. 2.2. Rear view of the instrument

2.4. EARTHING

Before switching on, the instrument shall be connected to a protective earth conductor in one of the following ways:

- via the protective earth terminal
- via the three-core mains cable. The mains plug shall only be inserted into a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor.

WARNING: Any interruption of the protective conductor inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.

When an instrument is brought from a cold into a warm environment, condensation may cause a hazardous condition. Therefore, make sure that the earthing requirements are strictly adhered to.

2.5. MAINS VOLTAGE SETTING AND FUSE

Before inserting the mains plug into the mains socket, make sure that the instrument is set to the local mains voltage.

The instrument can operate on two mains voltage ranges: 100 ... 127 VAC ($\pm 10\%$) and 220 ... 240 VAC ($\pm 10\%$). The latter voltage range is also used when the instrument is operated by a DC voltage between 250 and 350 Volt. Either of the two voltage ranges can be selected by means of the slider switch that is located behind the window in the rear plate of the instrument. The selected voltage range is visible through this window, see figure 2.2.

Disconnect the instrument from all voltage sources before attempting to gain access to the voltage selector switch.

The switch is accessible if the rear plate of the instrument is removed (unscrew two screws).

The instrument is protected against incorrect setting of the mains voltage selector.

The fuse-holder mounted on the rear panel carries a 2A delayed-action fuse.

When replacing a fuse make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders must be avoided. The instrument must be disconnected from all voltage sources when a fuse is to be replaced or when the instrument is to be adapted to a different mains voltage.

3. OPERATING INSTRUCTIONS

3.1. GENERAL INFORMATION

This section outlines the procedures and precautions necessary for operation. It identifies and briefly describes the functions of the front and rear panel controls and indicators, and explains the practical aspects of operation to enable an operator to evaluate quickly the instrument's main functions.

3.2. SWITCHING ON

After the oscilloscope has been connected to the mains(line) voltage in accordance with chapters 2.4. and 2.5., it can be switched on with the POWER switch. This switch is incorporated in the graticule ILLUM control on the front-panel, immediately below the screen bezel. The associated POWER ON/OFF indicator lamp is adjacent to the ILLUM control. When switching on the oscilloscope, it is immediately ready for use. With normal installation, according to section 2, and after a warming-up time of 30 minutes, the characteristics according to chapter 1.2. are valid.

WARNING: The oscilloscope must never be switched on whilst any circuit board is removed.
Never remove a circuit board until the oscilloscope has been switched-off for at least one minute.

3.3. POWER-ON TEST

When switching on, the microprocessor initiates an automatic test of internal circuits, including:

- processor test
- prom test
- ram test
- display test

The result of these tests is shown in the LED display:

A  appears from left to right on each digit for a period of 0,5 sec.

After this the EV, DIV and S or Hz lamps light up for 0,5 sec.

If the microprocessor controlled circuits are not working properly, the following test results are shown on the LED display:

- Display remains blanked :

Processor test probably failed.

A  in right most digit:
PROM test failed

A / in right most digit:
RAM test failed

3.4. EXPLANATION OF CONTROLS AND SOCKETS

3.4.1. Vertical deflection and C.R.T. section

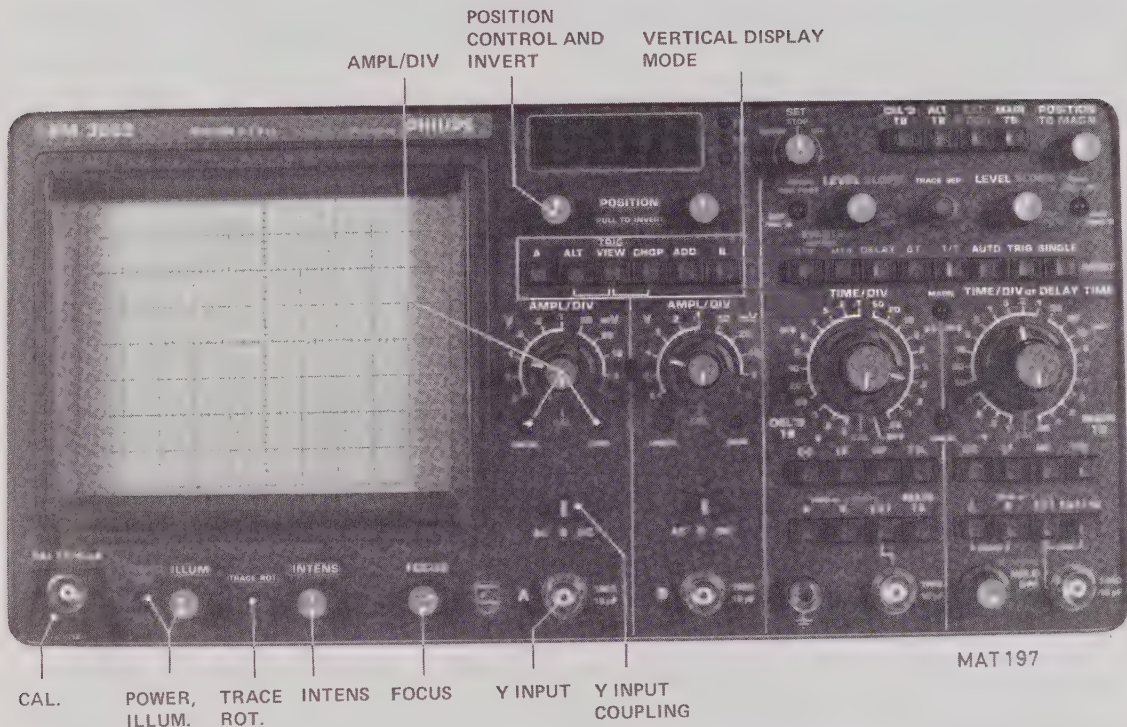


Fig. 3.1. Vertical deflection and c.r.t. section

VERTICAL DEFLECTION

— Vertical display mode	Selects the desired vertical deflection
A depressed	Vertical deflection is achieved by the signal connected to the input of channel A.
ALT depressed	The display is switched over from one vertical channel to the other at the end of every cycle of the time-base signal; i.e. the A and B channels are displayed on ALTERNate sweeps.
TRIG VIEW depressed	The display is switched to view the selected trigger signal. Trigger view display can be internal via A or B channels (A or B depressed) or external via external input socket, when EXT or EXT/10 is depressed. Trigger view can only be combined with chopped or alternate display.
CHOP depressed	The display is switched over from one vertical channel to the other at a fixed frequency, both A and B channels being displayed during the same sweep.
ADD depressed	Vertical deflection is achieved by the sum signal of channels A and B.
B depressed	Vertical deflection is achieved by the signal connected to the input of channel B.
ALT and TRIG VIEW depressed simultaneously	The signals on channels A, B and TRIG VIEW are displayed during alternate sweep; usually suitable for high frequency signals (see also explanation of push-button TRIG VIEW).

CHOP and TRIG VIEW depressed simultaneously	The signals on channel A, B and TRIG VIEW are displayed one after the other at the CHOP frequency during the same sweep; usually suitable for low frequency signals. (See also explanation of push-button TRIG VIEW)
All pushbuttons out	If no pushbutton is depressed, the instrument operates in the ALT mode.
— Position control and invert	
POSITION	Continuously variable control giving vertical shift of the display.
PULL TO INVERT	2-way push-pull switch, integral with the POSITION control, for the inversion of the signal polarity. Control is depressed for NORMAL and pulled for INVERT.
— AMPL/DIV	Step control of the vertical deflection coefficients; 11-way switch. In the 2 mV/DIV position the bandwidth is limited to 35 MHz.
CAL (AMPL/DIV)	Continuously variable control of the vertical deflection coefficients. In the CAL position the selected deflection coefficient is calibrated.
UNCAL	Pilot lamp indicating that the CAL control is not in the CAL position.
GAIN (screw-driver control)	Calibration of the gain in the CAL position.
— Y input coupling	
AC, 0, DC	Signal input coupling; 3-way switch.
AC	Coupling via a blocking capacitor
0	Connection between input circuit and input socket is interrupted and the amplifier input is earthed to establish a 0-reference.
DC	Direct coupling
— Input	
A 1M - 15 pF	BNC input socket for channel A.
B 1M - 15 pF	BNC input socket for channel B.
C.R.T. SECTION	
CAL.	Output providing a 3 Vp-p 2 kHz square-wave voltage, to calibrate vertical deflection AMPL control, or for frequency compensation of voltage divider probes. Current loop with 6 mA p-p for calibration of current probes.
POWER, ILLUM	Continuously variable control of the graticule illumination, incorporating the power on/off switch.
POWER ON	Pilot lamp indicating that the power switch is on.
TRACE ROT (screw-driver control)	Preset control for aligning the trace with the graticule line.
INTENS	Continuously variable control of the trace brilliance.
FOCUS	Continuously variable control of the c.r.t. electron-beam focusing.

3.4.2. Horizontal deflection



Fig. 3.2. Horizontal deflection

- Horizontal display mode
DEL'D TB depressed
- ALT TB depressed
- EXT X DEFL depressed
- MAIN TB depressed
- All pushbuttons out
- POSITION (TB MAGN)

Selects the desired horizontal deflection.

The horizontal deflection voltage is supplied by the delayed time-base generator.

The horizontal display is switched over from the main time-base to the delayed time-base at the end of every sweep and so on.

If ALT TB is combined with TRIG VIEW the display will be MAIN TB intensified.

Horizontal deflection is achieved by an external signal applied to the input socket of the horizontal amplifier, by the channel A or B signals, or by a mains-frequency (LINE) signal, depending on the TRIG or X DEFL pushbutton selection.

The horizontal deflection voltage is supplied by the main time-base generator.

A part of the trace is intensified (except in the OFF position of the TIME/DIV switch of delayed time-base generator).

Effectively the same as MAIN TB depressed.

Continuously variable control giving horizontal shift if the display; incorporates a push-pull switch for increasing the horizontal deflection coefficient by a factor of 10. (PULL FOR X10).

— TRACE SEP	Continuously variable Adjusting of the vertical distance between the two traces in ALT TB mode.
— Deflection selector	External X deflection or main time-base trigger source selector. X-deflection only when button EXT X DEFL of the horizontal display mode switch has been depressed.
A depressed	X-deflection internally from channel A.
B depressed	X-deflection internally from channel B.
EXT depressed	The signal at the external input is used for X-deflection.
EXT ÷ 10 depressed	Same as above but via a build-in 1 to 10 voltage divider.
LINE (both EXT and EXT ÷ 10 depressed)	X-deflection internally from the line voltage.
— EXT DEFL INPUT	Input socket for external X-deflection.
— X AMPL	Variable control of the X-deflection amplitude in the EXT X DEFL mode, combined with hold-off control. Normally this knob is in the CAL position.

3.4.3. Main Time-base

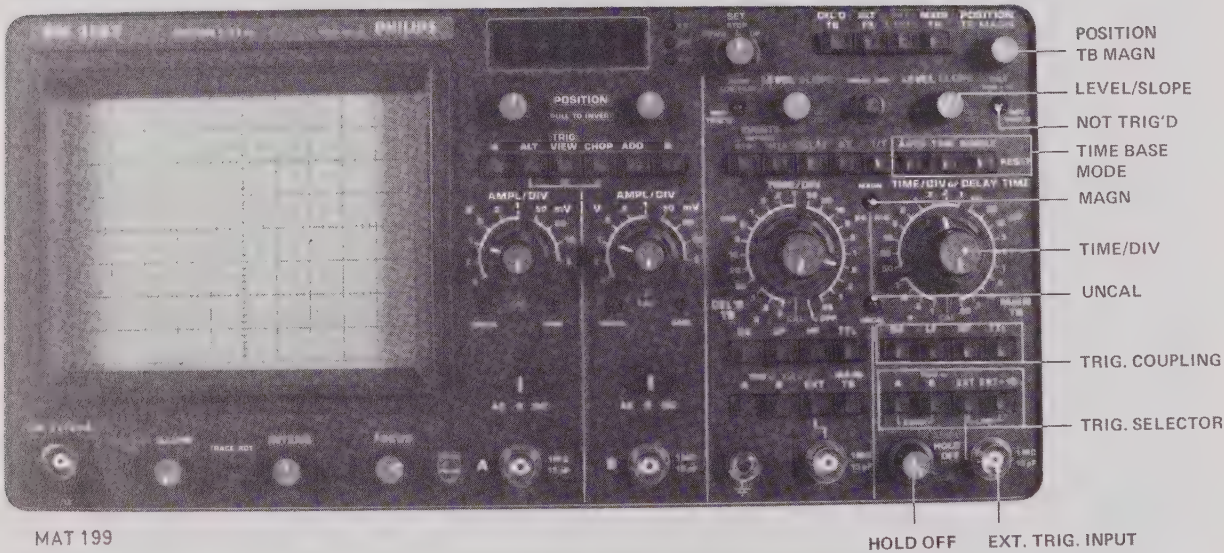


Fig. 3.3. Main time-base

TB MAGN	Push-pull switch to increase the horizontal deflection coefficient by a factor of 10 (PULL FOR X10)
LEVEL-SLOPE	Continuously variable control for selecting the level of the triggering signal at which the time-base generator starts. This control incorporates a push-pull switch that enables choice of triggering on either the positive- or negative-going edge of the triggering signal (IN +, OUT -).
NOT TRIG'D	Pilot lamp indicating that the time-base generator is in the waiting position.
— AUTO, TRIG, SINGLE AUTO depressed	Trigger mode controls; 3-way pushbutton switch. The main time-base is free-running in the absence of trigger signals.
TRIG depressed	The time-base generator is normally triggered.
SINGLE, RESET	Pressing this button puts the main time-base in the single sweep mode. After receipt of a trigger pulse the main time-base runs only once. By pressing this button again the main time-base is reset to be ready for the next trigger pulse.
If no button is depressed the circuit operates effectively as if the SINGLE mode has been selected.	
— MAGN	Pilot lamp indicating that the x10 magnifier is on; applies to both main - and delayed time-base
— TIME/DIV	Time coefficient control of the main time-base; 23-way rotary switch.

CAL (blue) - TIME/DIV	Continuously variable control of the main time-base coefficients. In the CAL position the time coefficient is calibrated.
UNCAL	Pilot lamp indicating that the CAL control is not in the calibrated position; applies to both main and delayed time-base.
— TRIG COUPLING	4-way pushbutton switch.
DC depressed	Full trigger bandwidth (DC included).
LF depressed	Trigger coupling via low-pass filter from DC up to 30 kHz (for external triggering via band-pass filter of 7 Hz to 30 kHz).
HF depressed	Trigger coupling via a high-pass filter for frequencies higher than 30 kHz.
TTL depressed	Trigger coupling adapted to TTL levels. Level control out of service. For levels refer to: "Characteristics".
With no pushbutton depressed, the circuit operates effectively as with the DC button depressed.	
— TRIG SELECTOR	4-way pushbutton switch.
A depressed	Internal triggering on channel A.
B depressed	Internal triggering on channel B.
COMP (both A and B depressed)	Internal triggering on channel A and channel B. Only in Y-ALT mode.
EXT depressed	Trigger on external signal via adjacent ext. trig. input socket.
EXT ÷ 10 depressed	Same as above but via a build-in 1 to 10 voltage divider.
LINE (both EXT and EXT ÷ 10 depressed)	Triggering internally from the line voltage.
EXT TRIG INPUT	Input for external triggering.
— HOLD OFF	This knob permits control of the main time-base hold-off time and allows perfect triggering on e.g. double-pulse signals. Normally this knob is in the CAL position. Rotating the knob away from the CAL position increases the hold-off time. Combined with variable X AMPL.

3.4.4. Delayed Time-base

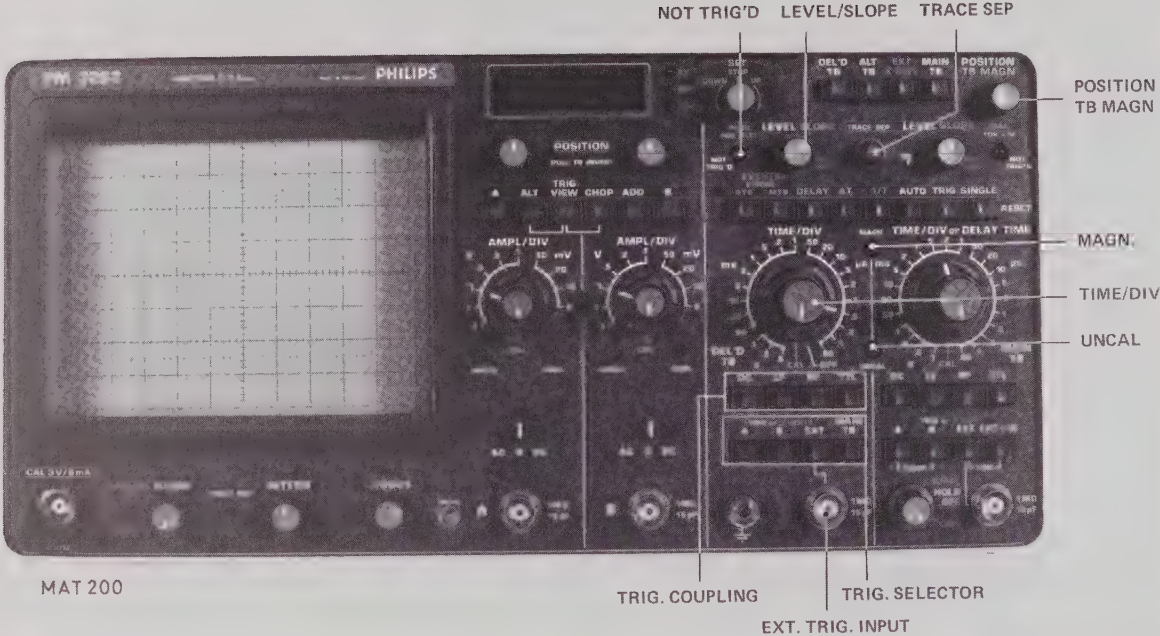


Fig. 3.4. Delayed time-base

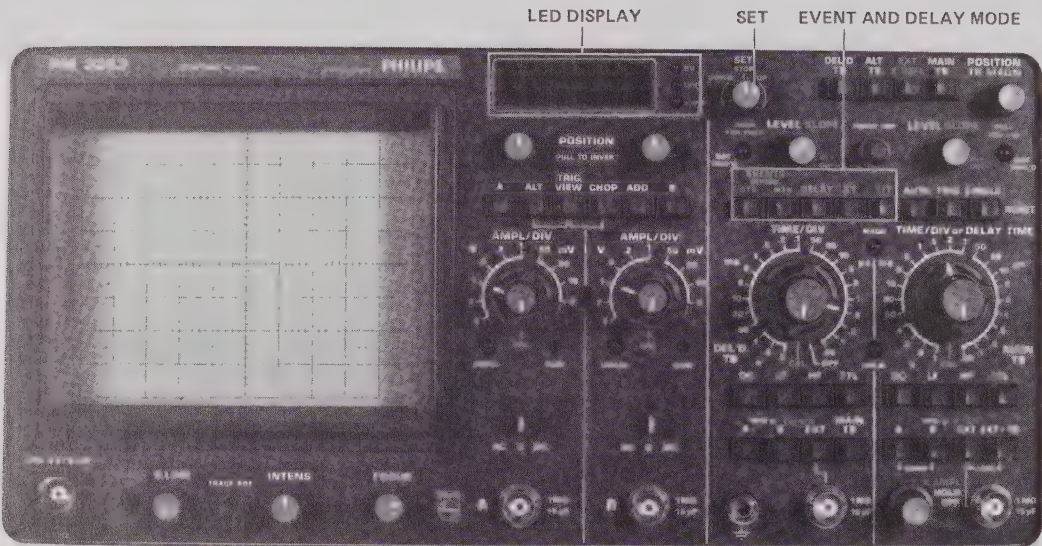
POSITION TB MAGN	Continuously variable control giving horizontal shift of the display; incorporates a push-pull switch for increasing the horizontal deflection coefficient by a factor of 10 (PULL FOR X10).
TRACE SEP.	Continuously variable control of the separation between the two time-base displays in the ALT TB mode.
LEVEL-SLOPE	Continuously variable control for selecting the level of the triggering signal at which the time-base generator starts. This control incorporates a push-pull switch that enables choice of triggering on either the positive- or negative-going edge of the triggering signal (IN +, OUT -).
NOT TRIG'D	Pilot lamp indicating that the time-base generator is in the waiting position.
MAGN	Pilot lamp indicating that the X10 magnifier is on; applies to both delayed- and main time-base.
TIME/DIV	Time-coefficient control of the delayed time-base; 23-way rotary switch. Incorporates an OFF position whereby the delayed time-base is switched off.
CAL (blue) - TIME/DIV	Continuously variable control of the delayed time-base generator time coefficients. In the CAL position the time coefficient is calibrated.
UNCAL	Pilot lamp indicating that the CAL control is not in the calibrated position.

— TRIG COUPLING	4-way pushbutton switch.
DC depressed	Full trigger bandwidth (DC included)
LF depressed	Trigger coupling via low-pass filter from DC up to 30 kHz (for external triggering via band-pass filter of 10 Hz to 30 kHz).
— HF depressed	Trigger coupling via a high-pass filter for frequencies higher than 30 kHz.
TTL depressed	Trigger coupling adapted to TTL levels. Level control out of service. For levels refer to: "Characteristics".

With no pushbutton depressed, the circuit operates effectively as with the DC button depressed.

— TRIG SELECTOR	4-way pushbutton switch.
A depressed	Internal triggering on channel A after delay time.
B depressed	Internal triggering on channel B after delay time.
EXT depressed	Triggering on external signal after delay time, via adjacent ext. trig. input socket.
MAIN TB depressed	Delayed time base starts immediately after delay time.
With no button depressed, the circuit operates effectively as with button A depressed.	
— EXT TRIG INPUT	Input for external triggering.

3.4.5. Event Count and Delay



MAT 201

Fig. 3.5. Event count and Delay

— LED display with EV on: with DIV on: with S or Hz on: Set knob	Number of events (pulses) to be counted is shown.
	Number of divisions of the c.r.t. display in DELAY mode and ΔT mode is shown, when the MAIN TB vernier control is not in the CAL position.
	A time is displayed if the 1/T knob is not depressed. A frequency is displayed if the 1/T knob is depressed.
— EVENT AND DELAY MODE switch EVENTS BEFORE DTB EVENTS BEFORE MTB DELAY ΔT (interval time) 1/T	Controls the number of events to be counted in the event count mode.
	Controls the DELAY time and the ΔT interval time in these respective modes.
	The event counter is used to delay the delayed time-base.
	The event counter is used to delay the main time-base.
	The delayed time-base starts a certain time after the start of the main time-base.
	Dual delayed time-base.
	The interval time between the two delayed time sweeps is shown in the LED display.
	Used for time measurements between two points of a complex signal.
	This mode applies only if the DELAY or ΔT mode has been selected.
	If DELAY or ΔT time is equal to one period of the signal, the LED display shows the frequency of that signal.

3.5. SOME GENERAL INFORMATION ON THE PM 3263's WORKING PRINCIPLES

3.5.1. Inputs A and B

The oscilloscope has been provided with two identical channels, each of which can be used for either YT measurements in combination with one or both time-base generators, or XY measurements in combination with the external horizontal channel.

Y-T measurements

To display one signal, either of the two vertical channels can be selected by operating either push-button A or pushbutton B of the vertical display-mode controls.

When pushbutton ALT or CHOP is depressed, two different signals can be displayed simultaneously. The Y deflection coefficient and the polarity can be selected for each channel individually. When the ALT button is operated, the display is switched over from one channel to the other at the flyback of the time-base signal. Although the ALT mode can be used at all sweep speeds of the time-base generator, the CHOP mode will give a better display quality for long sweep times, because during these long sweep times the alternate display of the two input signals is clearly visible to the eye.

In the CHOP mode, the display is switched over from one channel to the other at a fixed frequency.

If pushbutton ADD of the display mode switch is operated, the signal voltages of both vertical channels are added. Depending on the position of the polarity switches, either the sum or the difference of the input signals is displayed. The ADD mode also enables differential measurements. With these measurements advantage is taken from the common mode rejection in the ADD position. When the polarity switches of both channels are set to opposite positions, the common mode parts of the signals on sockets A and B will undergo a very slight amplification only, with respect to the differential mode parts.

X-Y measurements

If pushbuttons EXT X DEFL of the horizontal display-mode (deflection) controls and A of the TRIG OR X DEFL controls are operated, the time-base generators are switched off. A signal applied to the vertical A channel is then used for horizontal deflection. The AC/0/DC switch and the step attenuator of channel A remain operative. Continuous control of the deflection coefficients is possible with the X DEFL/HOLD OFF control and horizontal trace shift with the X POSITION control.

Vertical channel B may also be used for X deflection.

To this end, the B button of the TRIG OR X DEFL controls is depressed.

It is also possible to use an internal voltage at the mains frequency or a signal applied to the EXT socket at the bottom right-hand side of the front panel for X deflection, after depressing the relevant pushbutton of the TRIG OR X DEFL controls. In these modes the trace width can be controlled with the X AMPL/HOLD OFF potentiometer.

With this potentiometer in its CAL position, the deflection coefficient for external signals is 50 mV/DIV. The external signal can be either d.c. or a.c. coupled (lower frequency limit 7 Hz) by depressing either the DC or the LF pushbutton of the trigger coupling controls of the main time-base.

AC/0/DC switch

The signals under observation are fed to input socket(s) A and/or B and the AC/0/DC switch is set to either AC or DC, depending upon the composition of the signal. As the vertical amplifier is d.c. coupled, the full bandwidth of the instrument is available and d.c. components are displayed as trace shift in the DC position of the AC/0/DC switch.

This may be inconvenient when small signals superimposed on high d.c. voltages must be displayed. Any attenuation of the signal will also result in attenuation of the small a.c. component. The remedy is to use the AC position of the input switch, which employs a blocking capacitor, to suppress the d.c. and l.f. signals. Some pulse drop will occur when l.f. square wave signals are displayed.

The 0 position interrupts the signal and earths the amplifier input for quickly determining the 0 V level.

3.5.2. Time-base

The time-base circuits deliver a sawtooth voltage in order to obtain a linear horizontal deflection. The horizontal deflection speed is calibrated so that an exact time related display can be obtained.

To get a stable display the time-base sawtooth voltage must be started every time at the same point of the wave form (this is called: Triggering).

Main time-base

The main time-base has three modes:

- AUTO** : The time-base generator circuit is free running if no triggering is present. As soon as a trigger signal is present a stable display is obtained.
- TRIG** : The time-base generator is only running if a trigger signal is present. If no trigger signal the display remains dark.
- SINGLE** : The time-base generator runs only once after receipt of a trigger pulse. This mode is often used when phenomena that occur only once must be photographed. After a single sweep the time-base is set ready for receipt of the next trigger pulse by pressing again the SINGLE button.

Variable hold-off

The hold-off time is the time between the end of a time-base sweep and the moment at which the circuit is ready to trigger on the next trigger pulse.

Normally with complex signals (e.g. double pulse signals) double triggering may occur resulting in an unstable display.

With the aid of the HOLD OFF control the hold-off can be adjusted in order to avoid double triggering. In the CAL position of this knob the hold-off time is at its lowest value.

Delayed Time-base

The delayed time-base generator is in principle the same as the main time-base generator.

The delayed time-base generator however originates only a sweep during the main time-base sweep.

The delayed time-base is generally used for closer inspection of details in complex signals.

If the DEL'D TB button has been depressed only the delayed time-base sweep is on the display.

When the delayed time-base trigger source button MAIN TB has been depressed, the delayed time-base sweep starts at a certain moment during the main time-base sweep.

The delayed time-base starts then without triggering; the delay time is shown on the LED display.

Due to a possible high ratio between main time-base and delayed time-base sweep times, some jitter may occur if the delayed time-base only is displayed. This jitter can be suppressed by triggering of the delayed time-base (by A, B or EXT). The time in the LED display however is then no longer accurate, so UNCAL 1 is shown.

The PM 3263 oscilloscope features dual delayed time-base (ΔT mode).

Two delayed time-base sweeps are then obtained on one main time-base sweep.

The delayed time-base sweep is usually set to a short time to obtain a marker function.

The delay time and the ΔT time can be shown in the LED display.

Another feature of the PM 3263 oscilloscope is triggering after event counting; possible for both main- or delayed time-base. The number of events (pulses) can be set to any value between 0 and 99999.

The event counter counts only trigger pulses which are present in the delayed time base trigger circuit.

The event counter starts counting at arrival of the main time-base trigger pulse.

Time-base MAGNifier

The time-base magnifier is operated by a push-pull switch incorporated in the horizontal-POSITION control.

If this switch is pulled to position X10, the sweep speed of the time-base generator are increased by a factor of 10. Thus, the portion of the signal displayed over a width equal to one division in the centre of the screen in the x1 position (TB MAGNifier depressed), will occupy the full width of the screen in the x10 position.

Any portion of the trace can be brought on to the screen by the horizontal-POSITION control for scrutinisation. In the x10 position, the time coefficient is determined by dividing the indicated TIME/DIV value by 10.

If the TB MAGN is switched on, the LED display is not changed but remains in the normal (x1) condition.

Use of the ALTERNATE TB

The PM 3263 is equipped with display switching. This offers the instrument user a simultaneous display of the signal on the two time scales provided by the main time-base and by the delayed time-base.

Detailed examination of a certain portion of the main time-base display is enabled by expanding the time interval of interest by means of the delayed time-base. Expansion is achieved by selecting a correspondingly faster sweep for the delayed time-base TIME/div. control.

The part of the signal under detailed observation by the delayed time-base remains as an intensified portion of the main time-base display. One can immediately correlate the detail with the overall signal, which may be extremely complex, without the necessity of switching between MAIN TB and DEL'D TB.

Vertical shift between the two-time-base displays is continuously variable with the TRACE SEparation control.

3.5.3. Triggering

If a signal must be displayed, the time base generator(s) must always be started on one fixed point of the signal in order to obtain a stationary display. The time-base generator is, therefore, started by narrow trigger pulses formed in the trigger unit and controlled by a signal originating from one of the vertical input signals, an internal voltage at mains frequency or an external source.

In the trigger unit the trigger pulses are derived by comparing the input signal with an adjustable d.c. voltage (LEVEL).

The trigger level is related to the vertical deflection rate in case of internal triggering (A or B); and to the input voltage in case of EXT triggering.

Trigger coupling

Four different trigger-coupling methods can be chosen with the DC/LF/HF/TTL switch. In the HF and LF positions, the transfer characteristic is limited.

In position DC the trigger signal is passed unchanged.

In position LF, a 0 Hz (7 Hz for external triggering) to 30 kHz band-pass filter is inserted. This position can be used to reduce interference from noise.

In position HF, a 30 kHz high-pass filter is inserted.

This position can be used to reduce interference from e.g. hum.

In position TTL automatic triggering on TTL levels obtained.

The trigger gap is now at a fixed value (the LEVEL control is not functioning).

Trigger source

The trigger signal can be taken internally from channel A or B or externally via the EXT socket. At internally triggering, the trigger signal is not affected by the continuous AMPL control.

Main time-base

The main time-base can also being triggered via a 1 : 10 voltage attenuator circuit allowing higher external trigger voltages.

Composite triggering is choosen by depressing both A and B buttons. In this mode the trigger signal is taken from ch. A or ch. B depending on which channel is on the display.

Note that composite triggering is not applicable in the chopped mode because then the chopped signal will be seen as trigger signal.

Line triggering (= triggering by a signal derived from the mains voltage) is chosen when both buttons EXT and $EXT \div 10$ are depressed.

3.5.4. Microprocessor

The most important tasks for the microprocessor are:

- checking the position of the various front panel controls
- loading the LED display
- loading the event counter
- loading the digital-analog converter to obtain the delayed time-base comparator voltage
- calculating the $1/T$ value.

3.6. PRELIMINARY SETTINGS

3.6.1. GAIN calibration

- Operate pushbutton A of the display-mode controls.
- Operate pushbutton AUTO of trigger-mode controls.
- Operate pushbuttons MAIN TB of the horizontal deflection controls.
- Display the trace by means of the appropriate POSITION control.
- Set the LEVEL, INTENS and FOCUS controls for a sharp, well-defined display.
- Set the AC-0-DC switch to DC.
- Set the AMPLitude switch to 0.5 V and the continuous control to CALibrated.
- Connect the CALibration socket to the A input socket.
- Check that the trace height is exactly 6 divisions.

If necessary, readjust the GAIN control on the front panel, immediately below the AMPLitude switch.

If a 1 : 10 voltage attenuator probe is used set the AMPLitude switch to 50 mV/DIV.

Check the square-wave response of the probe.

Repeat for the B-channel.

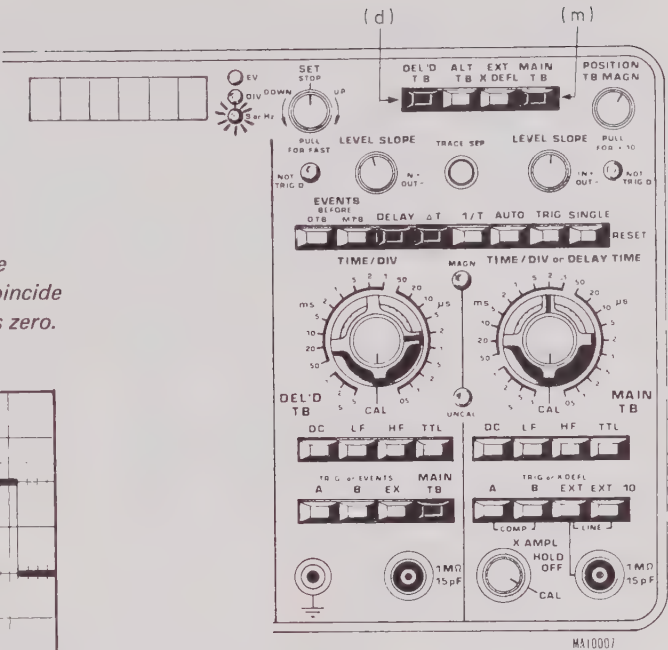
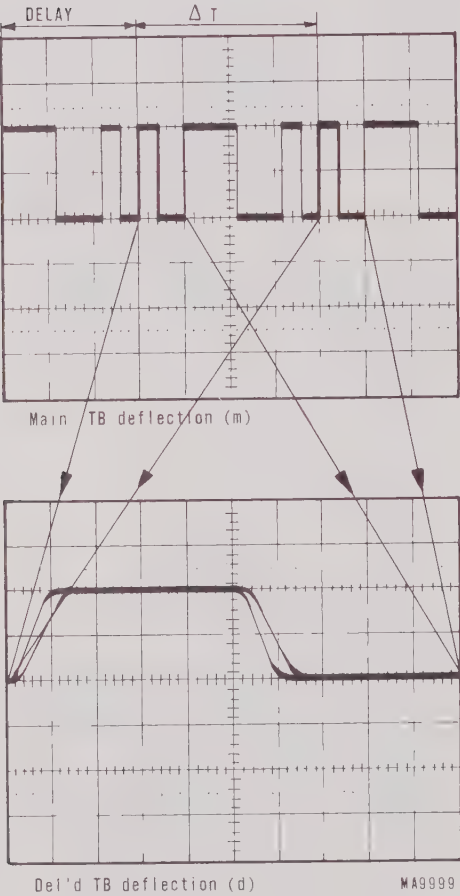
3.6.2. Trace rotation

- Depress pushbutton A of the display-mode controls.
- Depress pushbutton MAIN TB of the X-deflection controls.
- Centre the time-base line using the POSITION controls.
- Check that the time-base line runs exactly in parallel with the horizontal graticule line; if necessary, readjust the TRACE ROT control on the front panel.

3.7.2. Delay and ΔT mode

This mode is an extension of the previous DELAY mode. By depressing the ΔT button two delayed time base sweeps are shown on the c.r.t. display during the main time-base sweep*).

Note: At initial selection of the ΔT mode both delayed time-base markers coincide because ΔT value in the memory is zero.



ΔT is the time elapsed between the starting points of the two different delayed time-base sweeps on the c.r.t. display.

The ΔT mode is very suitable for time measurements in complex signals.

The two delayed time-base sweeps are used as markers.

The value of the last selected mode (DELAY or ΔT) is controlled by the SET knob and is shown in the LED display.

By selecting the DEL'D TB deflection (d) both delayed sweeps are shown over the whole c.r.t. display. With the SET knob both delayed sweeps can be controlled to coincide, to obtain the exact ΔT to be shown on the LED display.

Note that to control the DELAY time only the DELAY button must be depressed.

The ΔT can be controlled if the ΔT button has been depressed.

The maximum value of the DELAY time and the ΔT time are each equal to the total maintime base sweep time.

When controlling the time in the ΔT mode it is possible that the DELAY time plus ΔT time exceeds the main time-base sweep time.

However, the ΔT marker does not disappear from the c.r.t. display but stops at the end of the main time-base sweep.

The ΔT time remains stored in the memory so that, if the value of DELAY time is decreased, the ΔT marker starts shifting again at a certain moment.

DIV LED

When the MAIN TB vernier control is not in the CAL position the LED display cannot give the ΔT time value but instead a number of divisions is indicated on the LED display.

In this case the DIV lamp is on and the S or Hz lamp is off.

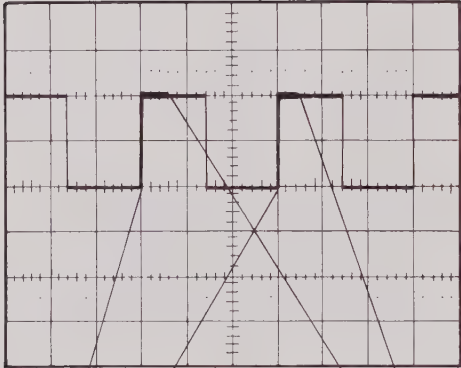
TB MAGN

If the TB MAGN is switched on, the LED display is not changed but remains on the normal (x1) value.

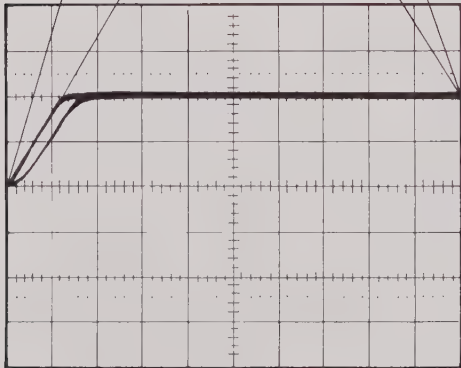
*) In fact the DELAY delayed time-base sweep is written on one main time-base sweep; and the DELAY + ΔT delayed time sweep on the next maintime base sweep and so on.

3.7.3. 1/T mode

This mode is an extension of the previous ΔT mode, and is used to measure frequency in complex signals.

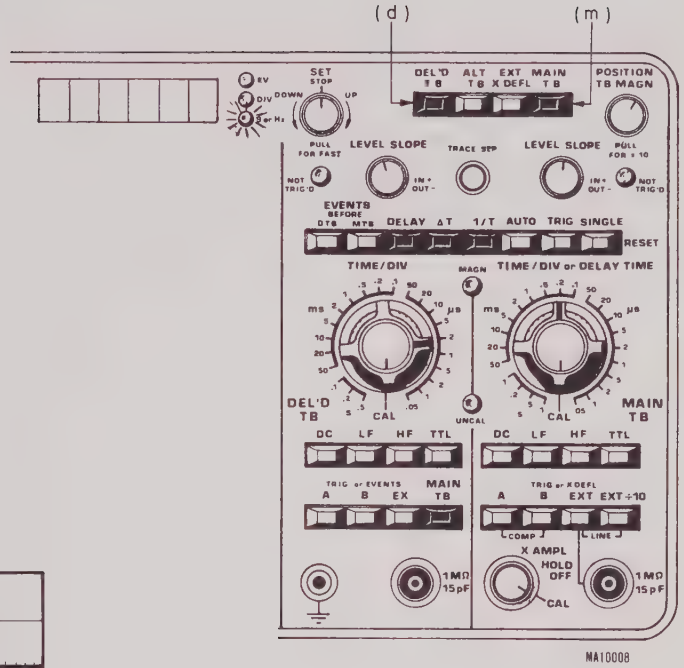


Main TB deflection (m)



Del'd TB deflection (d)

MA10000

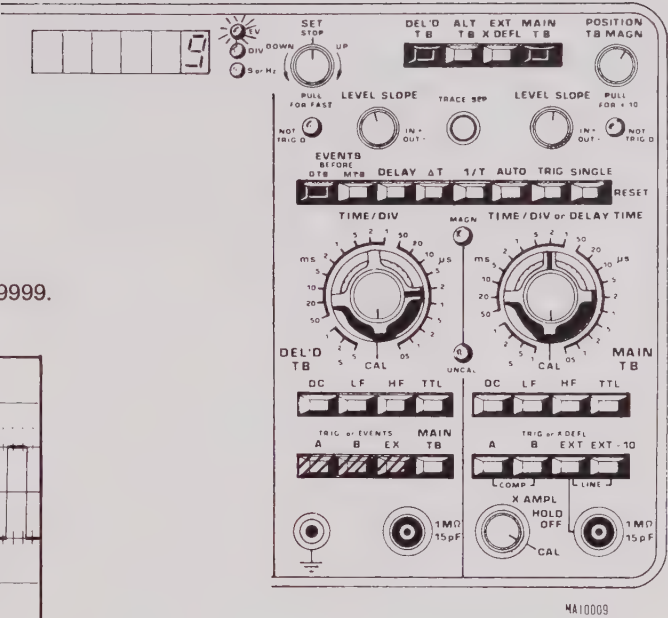
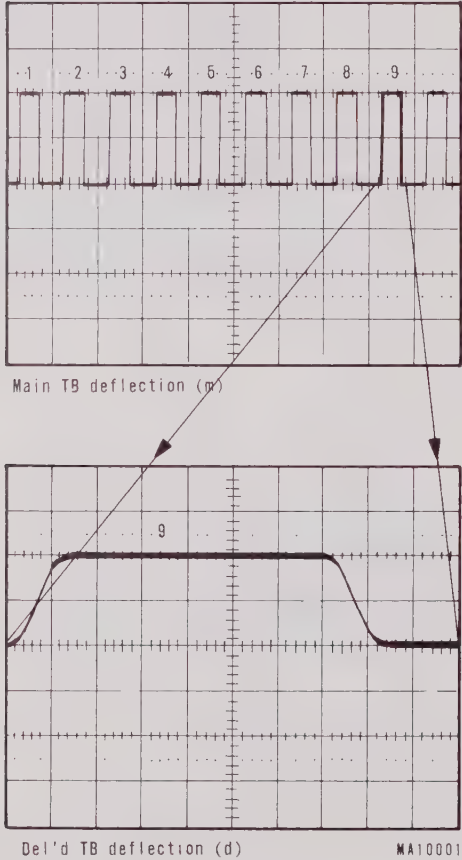


If according to the previous information the DELAY and ΔT are set in such a way that ΔT just encloses one period of the signal, the frequency of that signal is given in the LED display by pushing the 1/T button.

For accurate setting of the markers select the DEL'D TB horizontal deflection and check that both markers coincide.

3.7.4. Events before DTB

In this mode the delayed time-base is triggered after counting a preselected number of events (pulses). The delayed time-base must be triggered (from A, B or EXT). The number of events to be counted is shown in the LED display and can be controlled with the SET knob. Max. amount of events to be counted is 99999.



Note that if the MAIN TB knob of the delayed time-base trigger selector is depressed, the "Error" message is shown on the LED display (because no trigger input is available).

The event counter starts counting at the startmoment of the maintime base sweep.

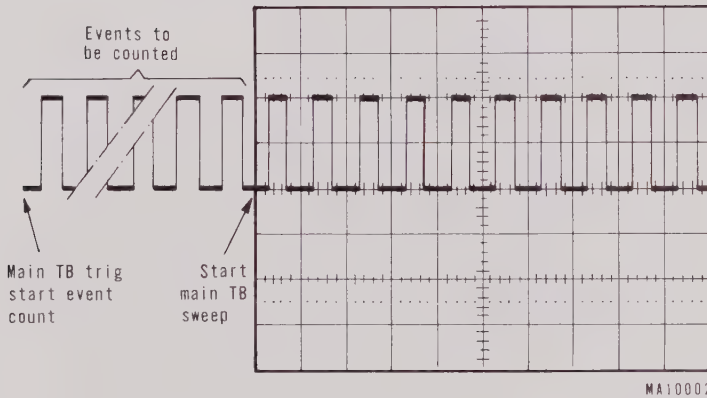
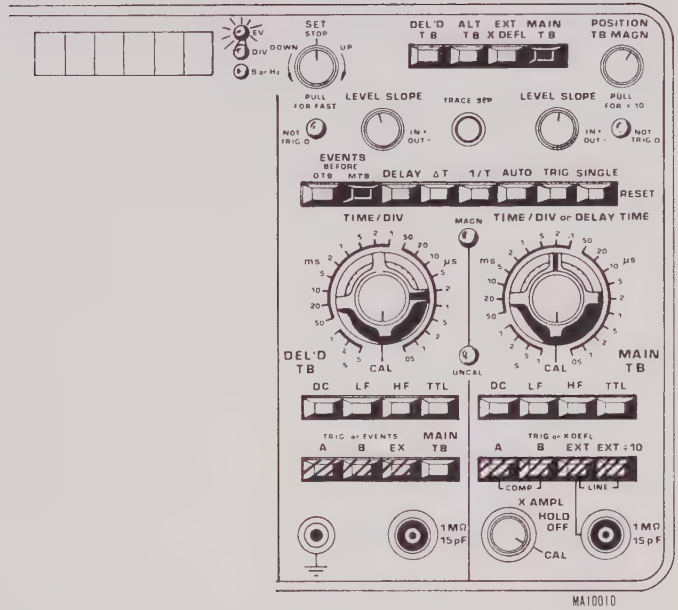
If the delayed time-base NOT TRIG'D lamp remains on, it could be that a higher number of events is selected than are available during one main time base sweep (or trigger control is not set correctly).

3.7.5. Events before MTB

In this mode the main time-base is triggered after counting a preselected number of events (pulses which are present at the **delayed time-base trigger input** (A, B or EXT.).

The number of events to be counted is shown in the LED display and can be controlled with the SET knob
Max. amount of events to be counted is 99999.

The event counter starts counting at arrival of the main time-base trigger pulse; both delayed - and main time-base must be triggered.



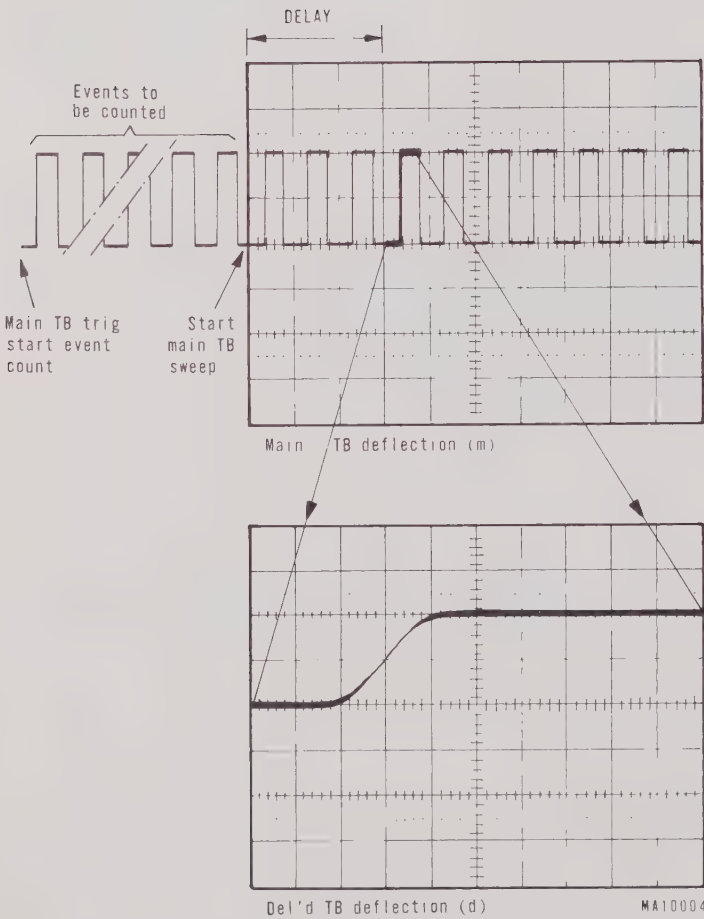
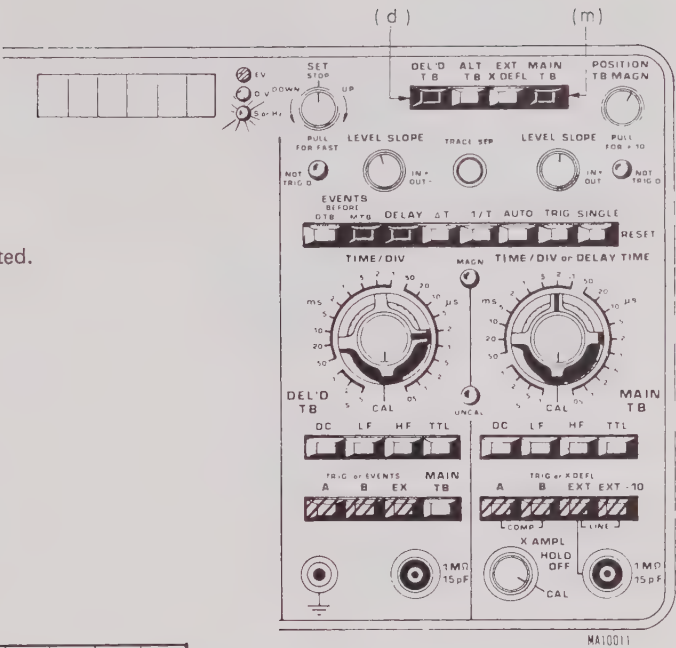
For clear understanding the events to be counted are shown here at the left of the c.r.t. display.

The EVENTS BEFORE MTB mode is very suitable to use in combination with the DELAY, and the ΔT mode.

3.7.6. Events before MTB and DELAY

This is an expansion of the previous mode. The main time-base triggers after counting a preselected number of events (pulses) which are present at the delayed time-base trigger circuit (A, B or EXT).

First press **EVENTS BEFORE MTB** only and select the number of events to be counted.



Rotate the **DEL'D TB** sweep out of the **OFF** position. Then press also **DELAY** and select the delay time.

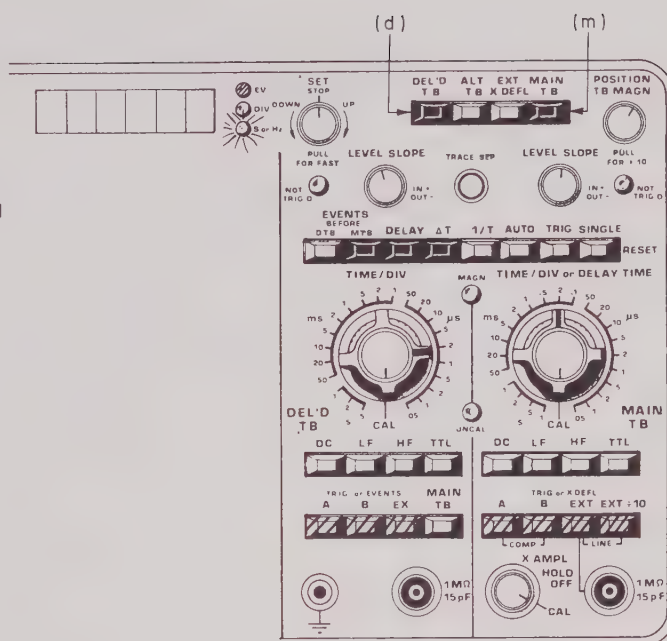
3.7.7. Events before MTB and DELAY and ΔT

This is a further expansion of the EVENTS BEFORE MTB mode.

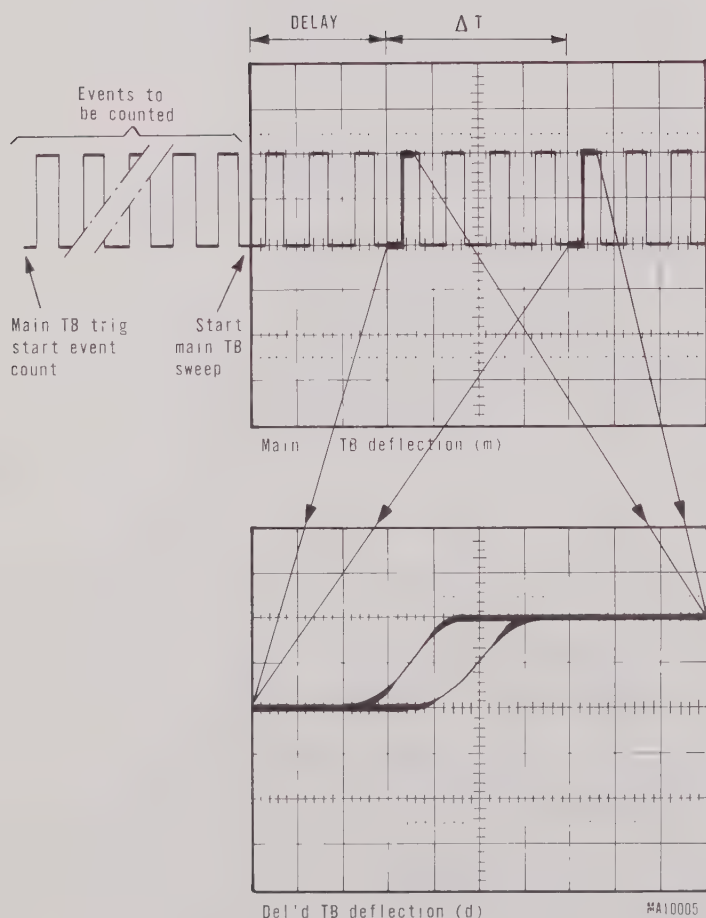
The two delayed time base sweeps can be used as markers, ΔT is the time interval between the markers.

The main time-base triggers after counting a preselected number of events which are present at the delayed time-base trigger circuit (A, B or EXT.).

First press EVENTS BEFORE MTB only and select the number of events to be counted.



MA10012



MA10005

Then press also DELAY and select the delay time (the position of the first marker).

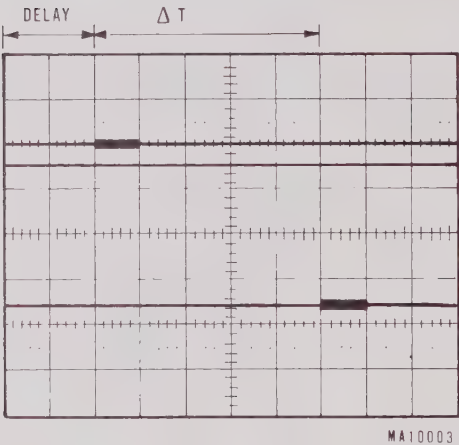
Press also ΔT and select the interval time (the position of the second marker).

For accurate setting of the markers select the DEL'D TB horizontal deflection and check that both markers coincide.

1/T mode can be selected when both markers are located on the same point of two successive cycles.

3.7.8. DELAY and ΔT mode combined with Vertical Alternate Display

If this mode has been selected the A-trace shows only the first delayed time base sweep, and the B-trace shows only the second delayed time-base sweep.



This is a useful mode to measure time between two different parts of two signals. Both signals must be time-related (e.g. synchronized from the same clock signal).

Connect one signal to ch. A input and the other to the ch. B input.
MTB trigger source may originate from A, B or EXT.
Select both signal-parts by adjusting the DELAY and DELAY + ΔT time.
The time between the starting points of both intensified trace-sections is shown in the LED display.
For accurate setting select the DEL'D TB horizontal deflection.

3.7.9. LED display with SET control

This display contains 6 digits and is on, when:

1° EVENTS BEFORE MTB is selected

or

2° DTB TIME/DIV knob is out of the OFF position, and:

EVENTS BEFORE DTB
or DELAY
or ΔT } is selected

Independent of the above conditions the display is on:

- during the power-on test, at the moment that the oscilloscope is switched on
- in the self-test mode (refer to the Service section of this manual).

The LED display shows:

- A number of events (pulses) in the EVENTS BEFORE DTB or MTB mode; the EV lamp is on.
With the SET control every number between 1 and 99999 can be selected.
- A time duration in the DELAY or ΔT mode.
This time is indicated in a mantissa with a ten's exponent (engineering notation).
The maximum indicated time in the display is equal to the full sweep time of the main time-base.
- A frequency (in 1/T mode) indicated in a mantissa and a ten's exponent (engineering notation).

Other display possibilities:

TB OFF

Indicates that for horizontal deflection the EXT X DEFL has been selected, and the instrument is in the event count, delay or ΔT mode.

ERROR*¹

Indicates that in the EVENTS mode the MTB trigger source of the DTB triggering has been selected. Press A, B or EXT of the DTB triggering.

UNCAL*¹

The display can indicate the word UNCAL together with a number 1, 2 or 3.

The UNCAL display is for the convenience of the operator, to indicate that no calibrated measurement can be made.

- | | |
|---------|--|
| UNCAL 1 | Means that in the DELAY or ΔT mode A, B or EXT source for DTB triggering has been chosen. Press MTB trigger source of the DTB triggering. |
| UNCAL 2 | Indicates that in the 1/T mode the distance between the markers is smaller than 0,1 DIV; the value in the display is then no longer accurate.
Take a shorter MTB sweep setting, or increase the time with the SET knob. |
| UNCAL 3 | Indicates that in the 1/T mode the MTB sweep control is not in the CAL position (frequency calculation not possible). |

Lamp EV

Is on if the display shows a number of events to be counted.

Lamp DIV

Is on if the DELAY or ΔT mode the MAIN TB sweep continuous control is not in the CAL position.

The LED display shows now no longer a time, but a number of c.r.t. divisions instead.

The S or Hz lamp is then extinguished.

Lamp S or Hz

Is on in the DELAY, or ΔT , or 1/T mode.

SET

This knob permits control of the delay time(s) in the DELAY TIME or ΔT mode; and the number of events to be counted in the EVENTS BEFORE DTB or - BEFORE MTB modes.

Any operation of this knob influences directly the data on the LED display.

In the centre position (STOP) of this knob the LED display data remains unchanged.

Turning the knob to the right increases, and turning to the left decreases the value on the LED display. The more the knob is turned from the centre the higher the changing rate on the LED display.

The change rate is increased with a factor of 100 by depressing the SET knob.

**¹) The ERROR and UNCAL explanation is also given in the carrying handle.*

4. BRIEF CHECKING PROCEDURE

4.1. GENERAL INFORMATION

This check is intended to check the oscilloscope's main functions with a minimum of test steps and actions required. It is assumed that the operator doing this test is familiar with the oscilloscope and its characteristics.

WARNING: Before switching on, ensure that the oscilloscope has been installed in accordance with the instructions mentioned in chapter 2.

If this test is started a few minutes after switching on, bear in mind that test steps may be out of specification, due to insufficient warming-up time. To be sure that this will not happen, allow the full indicated warming-up time. The test should be done at an environmental temperature of 20 ... 30°C. The measuring values that must be checked are indicated without tolerance and represent the characteristics of an average instrument; for tolerances see chapter 1.2. "Characteristics". The Checks are carried out with the use of the instrument's internal calibration voltage generator.

4.2. STARTING POSITIONS OF THE CONTROLS

Switch the instrument on and check in the LED-display if the micro-computer carries out the power on test: a $\sqrt{}$ appears from left to right on each digit for 0,5 sec. After this the EV, DIV and S LED's light up for 0,5 sec.

- Depress pushbutton AUTO of trigger mode selector S8.
- Depress pushbutton ALT of the vertical display mode selector S1.
- Put the channel A and B AMPL/DIV switches S9 and S11 in the 0,5V/DIV position and their verniers R8/S10 and R9/S12 in the CAL position.
- Put the channel A and B POSITION controls R3/R4 and R4/S5 in their mid position and depress them.
- Put the channel A and B AC/0/DC signal coupling controls S17 and S18 in the 0-position.
- Put the main time base TIME/DIV switch S15 in the 0,1ms/DIV position and its vernier control R11/S16 in the CAL position.
- Put the delayed time base TIME/DIV control S13 in the OFF position and its vernier control R10/S14 in the CAL position.
- Depress pushbutton MAIN TB of the horizontal display mode selector S2.
- Put the horizontal POSITION control R2 in its mid position and depress it.
- Depress the DC pushbuttons of the MAIN TB and DEL'D TB trigger coupling switches S19 and S20.
- The pushbuttons not mentioned must be released.

4.3. C.R.T. DISPLAY SECTION

- Adjust the INTENS and FOCUS controls R16 and R17 for a well-defined display. When carrying out checks it may be necessary to readjust the controls.
- Centre the channel A and B time base lines using the POSITION potentiometers R3, R4 and R2.
- Check if the time base lines run exactly in parallel with the horizontal graticule lines. If not readjust the TRACE ROTATION control R15. This is a screw driver operated control on the front panel.

4.4. VERTICAL CHANNELS

- The checking of channel A and B is identical. The knobs, sockets and adjusting elements of channel B are shown in brackets behind those of channel A.
- Put the main time base TIME/DIV switch in the 50ms/DIV position and check if channel A and B are alternately displayed.
- Depress pushbutton CHOP of the vertical display mode selector and check that it looks like channel A and B are displayed simultaneously.
- Put the main time base TIME/DIV switch in the 0,1 ms/DIV position.

- Depress pushbutton A (B) of the vertical display mode selector: now only the channel A (B) time base line is visible.
- Depress pushbutton A (B) of the main time base trigger source selector S22.
- Apply the output voltage from the CAL socket X1/X2 to the channel A (B) input socket X3 (X4).
- Put the channel A (B) signal coupling switch in the DC-position: the output signal from the CAL socket now becomes visible on the screen.
- Adjust the main time base LEVEL so that a stable waveform is written. The vertical deflection must be 6 divisions. If not readjust screw driver operated front panel adjustment point R12 (R13).
- Also check the trigger SLOPE selection S7 that is incorporated in LEVEL control R7. If the control R7/S7 is pulled the trace starts of negative going slope of the signal and if it is depressed the trace starts at the positive going slope of the signal.
- The signal that is displayed now is a square-wave with a bottom level of 0 Volt and a top level of 3 Volt. The signal contains a DC component of 1,5 Volt. With the AC/0/DC coupling switch in the AC position the DC component is blocked and the signal now is situated symmetrical around the 0 Volt level on the screen. Now check the AC position.
- Check if the channel A (B) signal on the screen is inverted if the PULL TO INVERT function is switched on by pulling the A (B) POSITION control S4/R3 (S5/R4).
- Depress the channel A (B) POSITION control again.
- Depress pushbutton EXT X DEFL of the horizontal deflection mode selector S2.
- Depress the A (B) pushbutton of the main time base trigger source selector S21.
- Apply the output voltage of the CAL-socket to the channel A (B) input socket.
- Depress the B (A) pushbutton of the vertical deflection mode selector S1.
- Check that two points are displayed that have a horizontal distance of 6 divisions.
- Depress pushbutton TRIG VIEW of the vertical deflection mode selector.
- Depress pushbutton A (B) of the main time base trigger source selector.
- Apply the output voltage of the CAL socket to the channel A (B) input socket.
- Depress pushbutton MAIN TB of the horizontal deflection mode selector S2.
- Check that a square wave signal of 6 divisions is displayed on the screen. This signal is shifted in a vertical sense if the main time base LEVEL control operated.

4.5. TIME BASES AND TRIGGERING

- Depress pushbutton A (B) of the vertical display mode selector S1.
- Apply the output signal of the CAL-socket to the channel A (B) input socket.
- Depress pushbutton A (B) of the main time base trigger source selector S22.
- Put the main time base TIME/DIV switch in the 0,1 ms/DIV position.
- Depress pushbutton MAIN TB of the horizontal display mode selector S2.
- Adjust the main time base LEVEL control R7 for a triggered display.
- Pull the TB MAGN knob R2/S3 that is incorporated in the horizontal POSITION control and check that the horizontal deflection is magnified by a factor of ten times.
- Depress the TB MAGN knob again.
- Depress the SINGLE pushbutton of the trigger mode selector S8. Check if the main time base runs only once after release of this pushbutton.
- Depress the AUTO pushbutton of the trigger mode selector again.
- Push the delayed time base TIME/DIV control S13 in the 20 μ s/DIV position and its vernier R10/S14 in the CAL-position.
- Depress pushbutton MAIN TB of the delayed time base trigger source selector S21.
- Depress the DELAY pushbutton (S26).
- Move the SET control (R1/S24) from the STOP into the UP counting position. Check that the intensified part of the delayed time base sweep shifts to the right along the main time base display. The number in the LED DISPLAY must increase now.
- Move the SET control to the DOWN counting position.
Check that the intensified part of the delayed time base sweep shifts to the left along the main time base display. The number in the display must decrease now.
- Check for a couple of points on the main time base display that the delay on the CRT-screen is correct compared with the delay time indicated in the LED DISPLAY.
- Check that in the UNCAL position of the main time base TIME/DIV vernier control the display indicates the delay in divisions (DIV) instead of in seconds.

- Put the main time base TIME/DIV control again in the calibrated CAL position.
- Depress pushbutton DEL'D TB of the horizontal display mode selector S2. Check if the intensified part now covers the entire horizontal screen width.
- Depress pushbutton ALT TB of the horizontal display mode selector. Now both the main time base signal with intensified part and the intensified part are displayed over the entire horizontal screen width. The vertical shift between both displays must be adjustable by means of the TRACE SEparation control R6.
- Depress pushbutton MAIN TB of the horizontal display mode selector S2.
- Adjust the delay so by means of the SET control, that the start of the intensified part coincides with the first negative-going slope on the screen.
- Depress pushbutton ΔT (S27) and position with the SET control a second intensified part so, that it coincides with the second negative-going slope on the screen.
- The display now must show the time difference ΔT between the start of both intensified parts: this ΔT value must be approximately 0,5m sec.
- Depress pushbutton 1/T (S28) and check if the display now shows the frequency of the square-wave on the screen. This frequency must be approximately 2kHz.
- Release the pushbuttons DELAY, ΔT and 1/T.
- Depress pushbutton A (B) of the delayed time base trigger source selector S21.
- Put the main time base TIME/DIV switch in the 0,2ms/DIV position.
- Depress pushbutton EVENTS BEFORE DTB (S25).
- Adjust the number of events in the display to 4 (3, 2, 1).
- Adjust the delayed time base LEVEL/SLOPE control (R5/S6) for an intensified part, that starts at the 4th (3rd, 2nd, 1st) positive-going slope of the signal on the screen.
- Check if the delayed time base LEVEL/SLOPE control (R5/S6) is pulled, that the intensified part starts at the 4th (3rd, 2nd, 1st) negative-going slope of the signal on the screen.
- Depress the delayed time base LEVEL/SLOPE control again.
- Put the delayed time base TIME/DIV control in the OFF position.
- Depress pushbutton EVENTS BEFORE MTB (S25).
- Adjust the number of events (EV) indicated in the display to 4.
- Check if it is possible to adjust the delayed time base LEVEL/SLOPE control (R5/S6) for a triggered display. For this check it is necessary, that also the main time base LEVEL/SLOPE control (R7/S7) occupies the triggered position. So the main time base NOT TRIG'D indicator must be off.

5. PREVENTIVE MAINTENANCE

5.1. GENERAL INFORMATION

This instrument generally requires no maintenance, as the instrument contains no components that are subject to wear.

However, to ensure reliable and troublefree operation, the instrument should not be exposed to moisture, heat, corrosive elements or excessive dust.

5.2. CLEANING THE NEXTEL SUEDE COATING

WARNING: The Nextel suède coating is ethanol-resistant, but is susceptible to methylated spirit, which will attack the surface (due to one of the de-naturing substances).

The bright appearance of the cabinet, lacquered with Nextel suède coating will deteriorate after some time as the surface becomes soiled. Cleaning with a cloth soaked in water, ethanol or a common household cleansing agent does not always restore this lustre and leaves dirt in the holes and the pores.

The 3M Company have developed a new cleansing pad (White Cleansing Pad, Catalogue No. 8440) which when soaked in water, ethanol or a common household cleansing agent will also penetrate holes and pores.

This method is similar to that of abrasive cleaning pads but lacks their abrasive action. Abrasive cleaning pads should not be used, otherwise surface scratches will result.

5.3. RECALIBRATION

From experience it is expected that the oscilloscope operates within its specification for a period of at least 1000 hours or for six months if used infrequently.

In addition, replacement of components may necessitate recalibration of the affected circuits. The checking & adjusting procedure can also be helpful in localising certain troubles in the instrument.

In some cases, minor troubles may be revealed and/or corrected by recalibration. Complete checking & adjusting instructions are given in the Checking & Adjusting Section.

Bedienungsanleitung

1. ALLGEMEINES

1.1. EINLEITUNG

Das PM 3263 ist ein tragbares Zweikanal-Breitbandoszilloskop, hoher Empfindlichkeit mit mikroprozessor-gesteuerten Zeitmesseinrichtungen.

Diese Einrichtungen umfassen:

- Zweifach verzögerte Zeitbasis
- Ereigniszähltriggerung für sowohl Hauptzeitbasis wie verzögerte Zeitbasis
- Frequenzmessungen

Die Ergebnisse der Zeit- und Frequenzmessungen und die gewählte Anzahl der zu zählenden Ereignisse werden in einer 6-stelligen LED-Anzeige dargestellt.

Bei Bedienungsfehlern signalisiert die LED-Anzeige eine ERROR oder UNCAL Warnung.

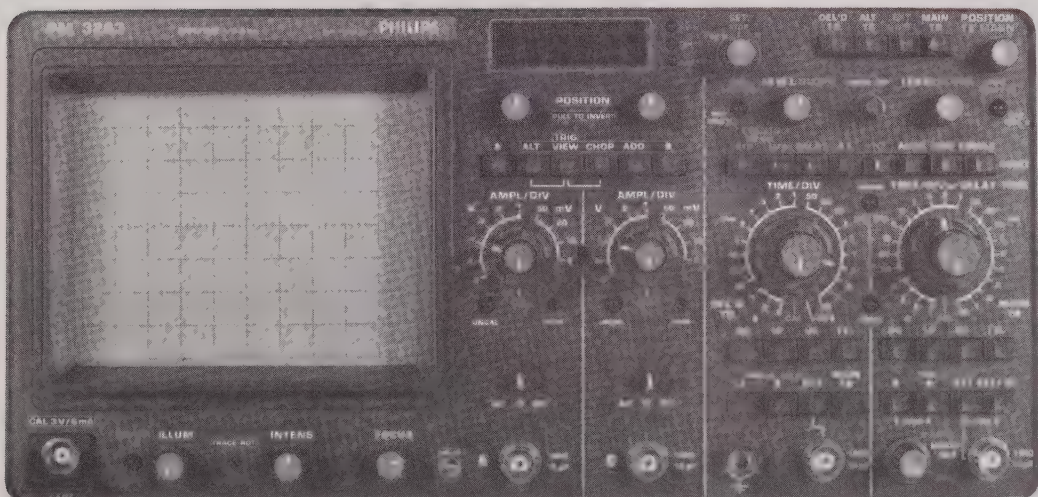
Weitere Möglichkeiten sind: Darstellung des Triggersignals (Trigger view), alternierende Darstellung der Zeitbasis und TTL-Triggerung.

In alternierender Betriebsart kann ein Signal gleichzeitig auf zwei verschiedenen Zeitbasis-Masstäben, die von Hauptzeitbasis und verzögerter Zeitbasis zur Verfügung gestellt werden, dargestellt werden.

Die zahlreichen integrierten Schaltungen mit denen das Oszilloskop bestückt ist gewährleisten einen stabilen Betrieb und verringern die Anzahl der Einstellpunkte.

Die Versorgungsspannung lässt sich mit Hilfe eines Schalters für zwei Bereiche, nämlich 90 V bis 140 V und 180 V bis 265 V einstellen.

Durch die vielseitigen Eigenschaften ist das Oszilloskop für einen ausgedehnten Anwendungsbereich geeignet.



MAT 196

Abb. 1.0. Frontansicht PM3263

1.2. TECHNISCHE DATEN

- Dieses Gerat ist gemass IEC348, Sicherheitsbestimmungen fur Mess- und Regeleinrichtungen, gebaut und gepruft und hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen. Um diesen Zustand zu erhalten und einen gefahrlosen Betrieb sicherzustellen, muss der Anwender die Hinweise und Warnvermerke beachten, die in verliegnder Anleitung enthalten sind.
- Diese Kenndaten gelten nach einer Anwarmzeit des Gerats von 30 Minuten (Bezugstemperatur 23°C).
 - Zahlenwerte mit Toleranzangaben werden vom Hersteller garantiert.
Zahlenwerte ohne Toleranzangaben sind Durchschnittswerte und dienen nur zur Information.
 - Ungenauigkeiten (absolut oder in %) sind bezogen auf den angegebenen Bezugswert.

Benennung	Beschreibung	Nahere Angaben
1.2.1. Elektronenstrahlrohre		
– Type	PHILIPS D14-302 GH/95	Rechteckiger Schirm, mit Netzelektrode und Nachbeschleunigung, metallhinterlegter Leuchtschirm.
Ausnutzbare Schirmflache	80 mm x 100 mm	
– Schirmtyp	P31 (GH) Phosphor	P7 (GM) Phosphor auf Wunsch lieferbar, auch P11 (BE)
Photografische Schreibe Geschwindigkeit	> 1500 cm/μs	Typisch 2000 cm/μs. Gemessen mit Steinheil Oscillophot M5 Kamera. Blende: 1:1,2 Bildausschnitt Verhaltnis: 1:0,5 Film: Polaroid 410 (10.000 ASA) Keine Vorbelichtung Phosphor Typ P31 (GH).
Gesamte Beschleunigungsspannung	17 kV	
Raster	Intern	Stufenlos einstellbare Rasterbeleuchtung
Einteilung	Zentimetereinstellung mit Untereinteilung von 2 mm an den mittleren Achsen. Gestrichelte Linien bei 1,5 und 6,5 Teilen vom oberen Ende der Anzeige ergeben einen Messraster zum Messen von Anstiegszeiten.	
– Bildrotation	Schraubenziehereinstellung an Frontplatte.	(Trace Rot.)
1.2.2. Vertikale oder Y-Achse		
– Kennlinie (2 mV Bereich ausgenommen)		
Frequenzbereich	DC ... 100 MHz AC 10 Hz .. 100 MHz	–3 dB obere Bandbreitengrenze –3 dB Der Frequenzbereich beinhaltet einen 10:1 Messkopf uber 20 - 30 °C.
Anstiegszeit	3,5 ns (siehe Abb. 1.2B)	
uberschwingen	± 3 % Spitze-Spitze	uber 6 Teile, + 5 – +40 °C
(Fur Kenndaten des 2 mV-Bereichs siehe am Ende dieses Abschnitts)		

Benennung	Beschreibung	Nähere Angaben
— Ablenkkoeffizient	2 mV/Teil ... 5 V/Teil	Elf, kalibrierte Stellungen, Folge 1-2-5. Nicht kalibriert stufenlos einstellbar 1: $\geq 2,5$. Nicht kalibrierte Lampenanzeige.
Fehlergrenze	$\pm 3 \%$	
— Höchstzulässige Eingangsspannung	$\pm 400 \text{ V}$	Gleichspannung - Spitzenwert einer Wechselspannung. Minderung bei Frequenzen über 500 kHz. Siehe Abb. 1.3.
Maximale unverzerrte Ablenkung	24 Teile	Bis 35 MHz
Verschiebungsbereich	16 Teile	Je 8 Teile über und unter der mittleren Rasterlinie.
— Eingangsimpedanz	1 MOhm $\pm 2 \%$ /ca. 15 pF	Eingang A und B gleich eingestellt.
Zeitkonstante der Eingangsschaltung	22 ms	AC Eingangskopplung
Bildstabilität	0,1 Teil/Stunde	Temperaturbereich +20 - +40 °C.
Bildsprung	0,2 Teil	Beim Schalten zwischen einer der Stellungen des Abschwächers.
Bildsprung	0,5 Teil	Beim Schalten des NORM/INVERT Schalters
Bildverschiebung	0,2 Teil	Beim Drehen des kontinuierlichen Abschwächers 0,4 Teil in 5 mV Stellung
Bildverschiebung	1 Teil	Beim Eindrücken der Taste ADDED 0,4 Teil in 5 mV Stellung. Ansteigend beim Drehen des stufenlosen Abschwächers.
Langzeit-Temperaturdrift	20 $\mu\text{V}/^\circ\text{C}$	Typischer Wert gemessen bei 2 mV über 4 Teile.
— Sichtbare Signalverzögerung	ca. 15 ns	
— Darstellungsarten	Kanal + oder — A allein Kanal + oder — B allein Darstellung des Triggersignals allein Kanäle $\pm A$ und $\pm B$ gehopped Kanäle $\pm A$ und $\pm B$ alternierend Kanäle $\pm A$ und $\pm B$ addiert Triggersignalsbild $\pm A$ und $\pm B$ gehopped oder alternierend (3-Kanal Anzeige)	Wenn die Triggersignal-Darstellung zusammen mit alternierender Zeitablenkdarstellung gewählt ist, erfolgt die Anzeige automatisch in aufgehellter Zeitablenkungsart. Siehe auch Abb. 1.6. "Übersicht der verschiedene Darstellungsarten mit doppelte verzögerte Zeitbasis."
— Chopperfrequenz	1 MHz	Anzeigedauer pro Kanal ca. 350 ns.
— Übersprechen zwischen Kanälen	1:500	Bis 50 MHz
— Gleichtaktunterdrückung	Besser als 100 bis 2 MHz 20 bei 50 MHz.	Gemessen bei +A und —B addiert. Max. Gleichtaktsignal 8 Teile.

Benennung	Beschreibung	Nähere Angaben
– Triggersignaldarstellung		
Anzeige	Externes oder internes Triggersignal	
Frequenzgang	≥ 80 MHz	
Ablenkkoeffizient	Gleich an vertikal	
Extern	100 mV/Teil ± 3 %	
Extern : 10	1 V/Teil ± 5 %	
Intern	Vertikal ± 10 %	
Triggerpunkt (Schwelle)	Schirmmitte $\pm 0,3$ Teil	Gleichspannungskopplung
Überschwingen	± 10 % Spitze-Spitze	
Verzögerungszeit zwischen Vertikal-eingang und externem-Eingang	3 ns ± 1 ns	
– Kenndaten für die 2 mV/Teil Einstellung		
Ablenkkoeffizient	2 mV/Teil	
Fehlergrenze	± 5 %	
Frequenzbereich	DC 0 - 35 mHz AC 7 Hz - 35 MHz	–3 dB obere Bandbreitengrenze –3 dB
Anstiegszeit	10 ns	
Überschwingen	± 5 % Spitze-Spitze	
Gleichtaktunterdrückung	Besser als 100 bis 2 MHz	
Instabilität		
Bildstabilität	0,25 Teil/Stunde	+20 – +40 °C Temperaturbereich
Bildsprung	1 Teil	Beim Schalten zwischen 2 mV/Teil und 5 mV/Teil
Bildsprung	2 Teile	Bei Betätigung des Schalters NORM/INVERT
Bildverschiebung	1 Teil	Beim Drehen des kontinuierlichen Abschwächers
Bildverschiebung	1 Teil	Beim Schalten auf Stellung ADDED.

1.2.3. Horizontale oder X-Achse

– Darstellungsmöglichkeiten		
– Hauptzeitbasis		
– Hauptzeitbasis aufgehelIt durch verzögerte Zeitbasis		
– Verzögerte Zeitbasis		
– Hauptzeitbasis aufgehelIt und verzögerte Zeitbasis alternierend dargestellt.		Leuchtpurentrennung von 4 Teilen . möglich
– X-Y und X-Y/Y Betrieb		X-Ablenkung durch: – Kanal A Signal – Kanal B Signal – Signal über EXT Anschluss der Hauptzeitbasis – Netzspannung

Doppelte verzögerte Zeitbasis und Ereigniszählung siehe: 1.2.6.

Benennung	Beschreibung	Nähere Angaben
– Horizontaldrift in x1 Stellung	0,2 Teile/Stunde	Die Horizontaldrift bei x1 Dehnung darf 0,1 Teil/Std. über +20 – +40 °C Temperaturbereich. Die gleichen Stabilitätsbedingungen gelten für den Start der Ablenkung bei Änderungen der Ablenkgeschwindigkeitseinstellung, ausgenommen sind die höchsten Ablenkbereiche (50-100 ns/Teil).
– Horizontal-Einstellung	± 5,2 Teile von Schirmmitte	Der Steller für die Horizontalverschiebung umfasst Grob- und Feineinstellung.

1.2.4. Hauptzeitbasis

– Betriebsart	Automatisch	Automatischer Freilauf bei Abwesenheit von Triggersignalen nach weniger als 0,1 s.
	Getriggert	
	Einmalig	
Ablenkzeitkoeffizient	1 s/Teil ... 50 ns/Teil	In 23 Kalibrierten Stufen, Folge 1-2-5. Dazwischen stufenlos einstellbar 1:≥ 2,5 nicht kalibriert. Eine Lampe UNCAL (nicht kalibriert) für sowohl Hauptzeitbasis wie verzögerte Zeitbasis (MTB und DTB).
– Fehlergrenze des Zeitmassstabes	± 2 % ± 3 %	+20 °C ... +30 °C + 5 °C ... +40 °C Die Differenz in Ablenkgenauigkeit über beliebige 2 Teile von 10-Teil-Zeitablenkung ist ± 5 %. Die ersten und letzten Teile der 5 ns und 10 ns gedehnten Zeitablenkung sind auszuschliessen.
– Regelbare Sperrzeit ("Hold-off")	Die Sperrzeit der Zeitablenkung kann bis zum Faktor 10 vergrößert werden.	Die Sperrzeit ist minimal in CAL position. Kombiniert mit X Ampl. Regler.
– Dehnung	10x	Geschaltet, kalibriert. Der Bildteil der mit der mittleren horizontalen Rasterlinie zusammenfällt darf beim Ändern der horizontalen Dehnung von x1 auf x10 um nicht mehr als 1 Teil verschieben.
Koeffizientfehler	± 1 % zusätzlich	± 5 % bei den ersten und letzten 50 ns von 5 ns/Teil, 10 ns/Teil und 20 ns/Teil der gedehnten Zeitablenkung.
Kürzester Zeitmasstab	5 ns/Teil	

1.2.5. Verzögerte Zeitbasis

– Betrieb	Normal	Gestartet von MAIN TB oder getriggert.
	Doppel	Gestartet von MAIN TB.

Benennung	Beschreibung	Nähere Angaben
– Zeitmasstäbe	0,5 s/Teil ... 50 ns/Teil	In 22 kalibrierten Stufen (Folge 1-2-5). Dazwischen stufenlos einstellbar 1:≥2,5 nicht kalibriert. Eine Lampe UNCAL (nichtkalibriert) für sowohl Hauptzeitablenkung wie verzögerte Zeitablenkung (MTB und DTB).
Fehlergrenze des Zeitmass- stabes	± 2 % ± 3 %	+20 °C ... +30 °C + 5 °C ... +40 °C Die Differenz in Zeitablenkungs- Genauigkeit für zwei beliebige Teile von 10-Teil-Zeitablenkung ist ± 5 %. Die ersten und letzten Teile der 5 ns und 10 ns gedehnten Zeitablenkung sind auszuschliessen.
– Dehnung	Gleich wie beim Hauptzeitbasis	

1.2.6. Verzögerungsarten

– Verzögerung	Verzögerte Zeitbasis startet sofort nach Verzögerungszeit oder Verzögerte Zeitbasis triggert nach Verzögerungszeit.	LED zeigt Verzögerungszeit an. LED zeigt UNCAL 1
– ΔT	Verzögerte Zeitbasis startet sofort nach der 1. und 2. Verzögerung.	LED zeigt Verzögerungszeitintervall an.
1/T	Intervall oder Verzögerungs- zeit invertiert.	LED zeigt den Frequenz des Signals falls ΔT or Delay-time eine Periode des Signals umfasst.
– Ereignisse vor DTB	Verzögerte Zeitbasis wird nach Zählung einer gewissen Anzahl von ereignissen getriggert.	LED zeigt die gewählte Anzahl von Ereignissen an.
– Ereignisse vor MTB	Die Hauptzeitbasis wird nach Zählung einer gewissen Anzahl von Ereignissen getriggert.	LED zeigt die gewählte Anzahl von Ereignissen an.
– Ereignisse vor MTB kombiniert mit Verzögerung, ΔT oder 1/T	Die Hauptzeitbasis wird nach einer gewissen Anzahl von Ereignissen getriggert.	Die Led zeigt den Wert der zuletzt gewählten Funktion an vorherige Funktionen und Werte werden gespeichert. Triggerung der verzögerten Zeitbasis nicht möglich.
Verzögerung, ΔT oder 1/T	Einstellbar zwischen 0x und 10x der Zeitkoeffizient der Hauptzeitbasis.	LED zeigt 4 (oder 3) Stellen mit Exponent an. Verzögerung wird in Sekunden angegeben oder falls der stufenlose MTB Steller nicht auf CAL steht in DIV. Wenn DTB getriggert wird zeigt die LED UNCAL 1 an.
Auflösung	5.10 ^{−4} von 10X MTB-Einstellung	Wenn der stufenlose MTB-Einsteller auf CAL steht. Wenn der stufenlose MTB-Einsteller nicht auf CAL steht 0,05 mm.

Benennung	Beschreibung	Nähere Angaben												
Jitter	1 : 30.000													
Fehlergrenze	<table border="1"> <thead> <tr> <th>Delay</th><th>ΔT</th><th>1/T</th></tr> </thead> <tbody> <tr> <td>$\pm 1\%$ des Bereichs</td><td>$\pm 1\%$ der Anzeige</td><td>$\pm 1\%$ der Anzeige</td></tr> <tr> <td>$- A \text{ ‰}$ des Bereichs</td><td>$- A \text{ ‰}$ des Bereichs</td><td>$- A \text{ ‰}$ des Bereichs*</td></tr> <tr> <td>+ initial Verzögerung: 20 ns</td><td>$\pm 0,25 \text{ ‰}$ des Bereichs</td><td>$\pm 0,25 \text{ ‰}$ des Bereichs</td></tr> </tbody> </table>	Delay	ΔT	1/T	$\pm 1\%$ des Bereichs	$\pm 1\%$ der Anzeige	$\pm 1\%$ der Anzeige	$- A \text{ ‰}$ des Bereichs	$- A \text{ ‰}$ des Bereichs	$- A \text{ ‰}$ des Bereichs*	+ initial Verzögerung: 20 ns	$\pm 0,25 \text{ ‰}$ des Bereichs	$\pm 0,25 \text{ ‰}$ des Bereichs	
Delay	ΔT	1/T												
$\pm 1\%$ des Bereichs	$\pm 1\%$ der Anzeige	$\pm 1\%$ der Anzeige												
$- A \text{ ‰}$ des Bereichs	$- A \text{ ‰}$ des Bereichs	$- A \text{ ‰}$ des Bereichs*												
+ initial Verzögerung: 20 ns	$\pm 0,25 \text{ ‰}$ des Bereichs	$\pm 0,25 \text{ ‰}$ des Bereichs												
* A = Vom MTB-Einstellung abhängig A = 1,5 in Bereiche welche mit 5 anfangen A = 0,5 in Bereiche welche mit 1 anfangen A = 0 in Bereiche welche mit 2 anfangen Hinzugefügt Fehler in MTB positionen 50 ns/div. und 100 ns/div. bzw. $\pm 3\%$ und $\pm 1\%$.														
Langzeitstabilität	< 2 Teile bei 1000x	Verhältnis zwischen MTB und DTB-Ablenkung: 1000.												
ΔT	Einstellbar zwischen 0x und 10x der Zeitkoeffizienten der Hauptzeitbasis.	LED zeigt 4 (oder 3) Stellen mit Exponent von zehn. ΔT wird gezeigt in Sekunden, oder falls der stufenlose MTB-Steller nicht auf CAL steht in DIV. Die zweite verzögerte Ablenkung lässt sich nicht vor der ersten einstellen. Wenn die Summe der verzögerten und ΔT Zeit die totale Hauptablenkzeit überschreitet dann wird die zweite verzögerte Ablenkung nicht von der Hauptzeitbasis verschwinden sondern bleibt am Ende der Leuchtpur stehen. Der tatsächliche Wert von ΔT wird jedoch gespeichert. Wenn also die verzögerungszeit derart verringert wird, dass Verzögerungs- und ΔT-Zeit geringer ist als die Ablenkzeit der Hauptzeitbasis, dann wird die zweite verzögerte Ablenkung wieder vom Ende der Leuchtpur zurückbewegen. Die LED Anzeige ist niemals höher als der Unterschied zwischen 10x der MTB-Einstellung und Delay-Zeit.												
1/T	Die LED zeigt den invertierten Wert von Verzögerungszeit oder ΔT-Zeit an. Minimaler Abstand zwischen beiden Markern: 0,1 div. 1 div.	1/T wird gezeigt in Hz, mit 4 (oder 3) Stellen und Exponent von zehn. Wenn der stufenlose MTB Steller nicht auf CAL steht, zeigt die LED UNCAL 3 an. x1 x10 Dehnung. Falls der Abstand zu klein wird zeigt die LED UNCAL 2.												

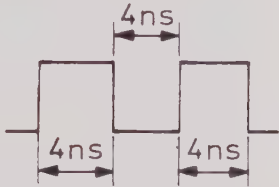
Benennung	Beschreibung	Nähere Angaben
Ereignisse vor DTB	Anzahl der Ereignisse zwischen 0 und 99999 einstellbar.	Die Anzahl der Ereignisse ist mit Hilfe des Potentiometers SET kontinuierlich einstellbar. Die Anzeigezählgeschwindigkeit ist proportional dem Drehungswinkel des Potentiometers und regelbar zwischen 1 und 50 Impulsen pro Sekunde; in gezogener Stellung zwischen 100 und 5000 Impulsen pro Sekunde. Wenn die mit dem Potentiometer eingestellte Impulsanzahl grösser ist als die bei einer MTB-Ablenkung angezeigte Anzahl von Impulsen, dann wird die Lampe NOT TRIG aufleuchten. Wenn beim Ereigniszählbetrieb Triggerquelle MAIN TB gewählt ist, dann wird dies von der LED mit ERROR angezeigt.
Ereignisse vor MTB	Anzahl der Ereignisse zwischen 0 und 99999 einstellbar.	MTB-Trigger startet den Ereigniszähler; und die Ereignisse werden vom DTB Triggerschaltung behandelt.
Impulsbedingungen	Ereignisse vor MTB kann kombiniert werden mit Delay, ΔT oder $1/T$. Max. Ereignisfrequenz 125 MHz. Min. Impulsbreite 4 ns Min. Impulsabstand 4 ns	
Anlaufzeit	Siehe Abb. 1.2A.	

Abb. 1.1. Max. Ereignisfrequenz 125 MHz.

1.2.7. X-Ablenkung über Kanal Y_A oder Y_B

— Ablenkkoeffizient	2 mV/Teil ... 5 V/Teil	Nichtkalibrierte stufenlose Einstellung 1: $\geq 2,5$.
Koeffizientfehler	$\pm 5 \%$	
Bandbreite	0-2 MHz	—3 dB Bandbreite über 8 Teile bis zu 0,1 MHz
Maximale unverzerrte Ablenkung	20 Teile	
Phasenverschiebung bezogen auf Y-Darstellung	3° bei 0,1 MHz	

1.2.8. Externe X-Ablenkung über Buchse EXT

— Ablenkkoeffizient		
Extern	50 mV/Teil	Nichtkalibrierte stufenlose Einstellung
Extern $\div 10$	500 mV/Teil	1:3 mittels Steller X AMPL. Kalibriert im ganz nach rechts gedrehter Stellung (CAL).
Eingangscharakteristiken	Gleiche Werte wie Y-Kanäle	
Genauigkeit	$\pm 3 \%$	Zusätzlich 2 % für Ext. $\div 10$.
Bandbreite	DC ... 2 MHz —3 dB über 4 Teile 7 Hz ... 2 MHz —3 dB über 4 Teile	Über DC Triggerkopplung Über NF oder HF Triggerkopplung.
Phasenverschiebung bezogen auf Y-Kanäle	3° bei 0,1 MHz	
Linearität	1,5 %	
Drift	0,2 Teil/Stunde	

Benennung	Beschreibung	Nähere Angaben
1.2.9. Triggerung der Hauptzeitbasis		
Triggerquelle	Intern von Kanal A Intern von Kanal B Zusammengesetzt A und B (COMP). Intern von Netz Extern Extern $\div 10$	Nur Betriebsart vertikal alternierend.
Betriebsart	Automatische Triggerung Trigger Einmaliger Ablauf der Zeitablenkung	Automatischer Freilauf des Zeitablenk- generators etwa 0,1 s nach Verschwinden des Triggersignals.
Lampe NOT TRIG'D	Zeigt den nicht getriggerten Zustand der Hauptzeitbasis an. Bei einmaligem Ablauf der Zeitablenkung leuchtet die Lampe nach Rückstellung der Hauptzeitbasis und erlischt nach Ablauf der Ablenkung.	
Flanke	+ oder —	
Triggerempfindlichkeit	Intern, besser als: 0,5 Teil bis 30 MHz 1,5 Teil bis 100 MHz Extern: 50 mV bis 30 MHz 150 mV bis 100 MHz Extern $\div 10$: Typisch 10x höhere Werte als in Stellung EXT.	Typischer Wert, frequenzabhängig, siehe Abb. 1.4. Typischer Wert, frequenz- abhängig, siehe Abb. 1.5.
Triggerarten und Kopplung	DC ganze Bandbreite NF int.: 0 - 30 kHz NF ext.: 7 Hz - 30 kHz HF: 30 kHz - 100 MHz TTL Automatische triggerung	Intern und extern — 3 dB — 3 dB — 3 dB, intern und extern Pegelbereichsteller wird abgeschaltet.
TTL-Pegel	Interne Triggerung (A, B oder COMP.) Niedrig : 0,8 Teil ($\pm 0,4$ Teil) Hoch : 2 Teile ($\pm 0,4$ Teil) Lücke : 1,2 Teil Externe Triggerung Niedrig : 0,8 V ($\pm 0,4$ V) Hoch : +2 V ($\pm 0,4$ V) Lücke : 1,2 V	Diese Daten gelten für Spannungen an der Spitze eines 1:10 Abschwächer- Tastkopfs angeschlossen an Eingangs- buchse EXT und mit dem Trigger- quellen-Wahlschalter in Stellung EXT.
Pegelbereich	Interne Triggerung: 24 Teile Externe Triggerung: +1,2 V bis -1,2 V Extern $\div 10$: +12 V bis -12 V	
Eingangsimpedanz	Gleiche Wert wie Y-Kanäle	
Triggerjitter	Besser als 0,5 ns	

Benennung	Beschreibung	Nähere Angaben
1.2.10. Triggerung der verzögerten Zeitbasis		
Triggerquelle	Intern von Kanal A Intern von Kanal B Extern Hauptzeit basis	Die übrigen Kenndaten sind die gleichen wie bei TRIGGERUNG DER HAUPTZEITBASIS, ausgenommen EXT ÷ 10 und Netztriggerung.
Lampe NOT TRIG'D	Zeigt den nicht getriggerten Zustand der verzögerten Zeitbasis an.	
1.2.11. Kalibrierungsausgang		
Spannung	3 V _{SS}	
Strom	6 mA	Durch Schleife
Fehlergrenze	± 1 %	Spannung und Strom
Frequenz	2 kHz ± 2 %	
Sicherung	Der Ausgang ist gegen Dauerkurz-Schlüsse gesichert.	
1.2.12. Zusätzliche Ein- und Ausgänge		
Z-Modulation	Gleichspannungsgekoppelt TTL-kompatibel Ansprechzeit 35 ns Eingangsimpedanz 10 kΩ Max. Eingangsspannung 50 V	Hoher Pegel verdunkelt das Bild.
Hauptzeitbasistorausgang	Während Ablenkung +5 V normal "0" V.	Ausgangsimpedanz 1 kΩ
Verzögerten Zeitbasistorausgang	Während Ablenkung +5 V normal "0" V.	Ausgangsimpedanz 1 kΩ
1.2.13. Speisung		
Netzspannungen	AC 100 - 127 V ± 10 % AC 220 - 240 V ± 10 % DC 250 - 350 V	Automatisch gegen falsche Einstellung des Netzwahlschalters geschützt. Die Stellung des Netzwahlschalters ist bei Gleichspannung balanglos.
Netzfrequenz	46 bis 440 Hz	
Leistungsaufnahme	60 W	
Eingebaute Netzsicherung	2A, träge	An der Rückwand des Geräts
Sprunghafte Netzänderungen		Bei Auftreten von sprunghaften Spannung- und Frequenzänderung wie gegeben in den MIL-T-28800 Vorschriften wird das Gerät keinen Schaden erleiden.

Benennung	Beschreibung	Nähere Angaben
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1.2.14. Einflussgrößen

Die angegebenen Daten gelten nur dann, wenn das Gerät gemäss den offiziellen Prüfverfahren kontrolliert wurde. Einzelheiten, die dieses Verfahren und die Fehlergrenzenkriterien betreffen, können von der PHILIPS-Organisation Ihres Landes oder von N.V. PHILIPS'GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND angefordert werden.

— Temperaturprüfungen

Den IEC 68 Ab und Bb entsprechend.

Arbeitsbereich: -15°C ... $+55^{\circ}\text{C}$

Betrieb innerhalb Spezifikation: $+5^{\circ}\text{C}$... $+40^{\circ}\text{C}$. Ausgenommen die jeweils pro Spezifikationen angegebenen Toleranzen.

Lagerung: -40°C ... $+70^{\circ}\text{C}$, geprüft von -55°C nach $+75^{\circ}\text{C}$.

— Höhe

Nach Vorschriften IEC 68-2-13, Test M.

Arbeitshöhe: bis 5000 m

Minderung: $1^{\circ}\text{C}/300\text{ m}$ für die max. Arbeitstemp.

Lagerung: bis 17.000 m.

— Luftfeuchte

Entsprechend IEC 68 Db, anhand des Philips Oszilloskop Standard Testprogramms geprüft, auch verglichen mit MIL-E-1640F 5 Zyklen (120 Stunden).

— Stossbelastung

In Betrieb; 30 g, 1/2 Sinus, Dauer 11 ms, 2 Stösse pro Achse pro Richtung bei insgesamt 12 Stössen.

— Vibration

In Betrieb: 15 Minuten entlang jeder der 3 Achsen.

0,6 mm (0,025 inch) Spitze-Spitze Verlagerung (4 g bei 55 Hz) bei einer Frequenz variierend von 10 Hz nach 55 Hz in Zyklen von einer Minute.

— Erholzeit

Das Gerät arbeitet innerhalb von 30 min. wenn es von -10°C auf $+20^{\circ}\text{C}$ bei 60% relativer Luftfeuchtigkeit erwärmt wird.

— Magnetische Abschirmung

Nach IEC 351 - 22.3.1.

Maximale Abweichung 1 Teil.

— Störgrad

Den Vorschriften VDE 0871 und 0875, Störgrad K entsprechend.

1.2.15. Mechanische Daten

Abmessungen	Länge	460 mm	Ohne Bedienungsorgane, Deckel und Füsse.
	Breite	316 mm	
	Höhe	154 mm	
Gewicht		10,7 kg.	

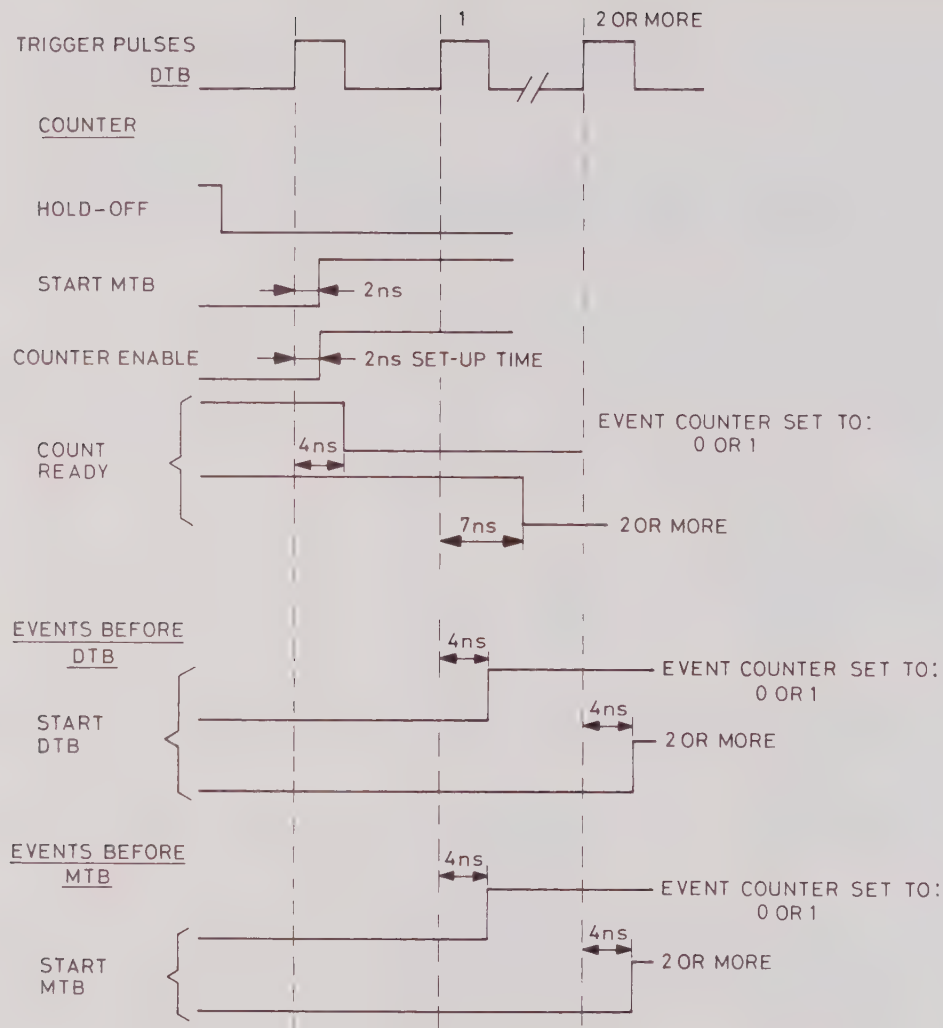


Abb. 1.2A Anlaufzeit

MAT 202

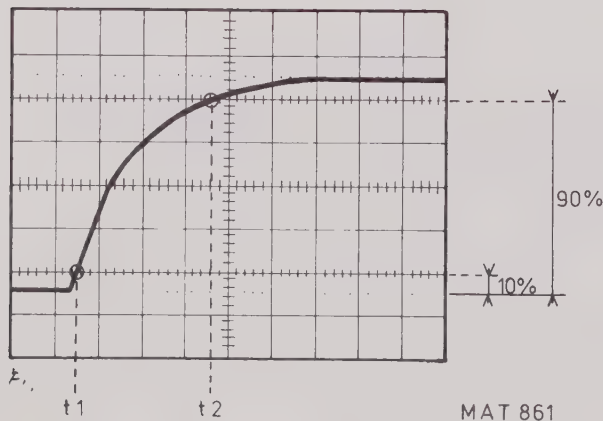


Abb. 1.2B Messung der Anstiegszeit: $t_R = t_2 (90\%) - t_1 (10\%)$

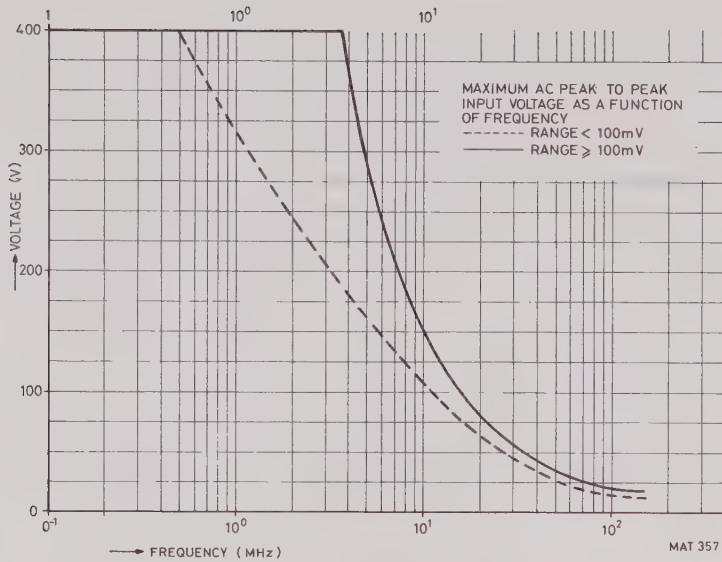


Abb. 1.3. Minderung der höchstzulässigen Eingangsspannung, frequenzabhängig

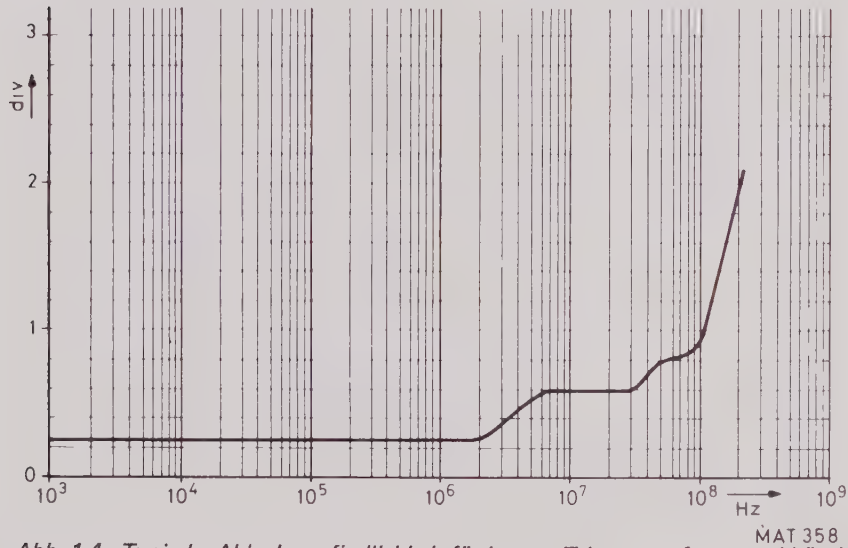


Abb. 1.4. Typische Ablenkempfindlichkeit für interne Triggerung, frequenzabhängig

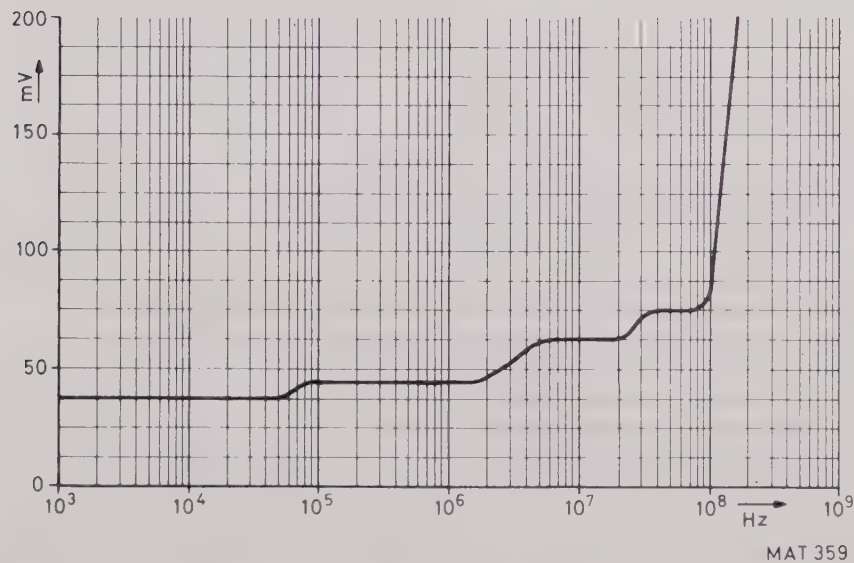
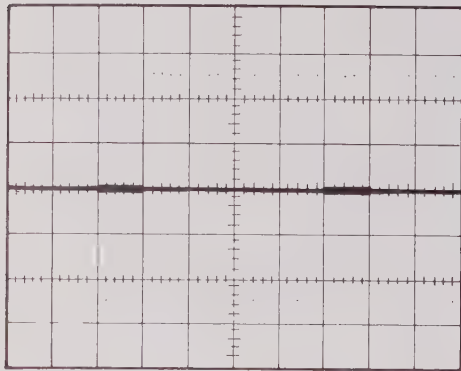
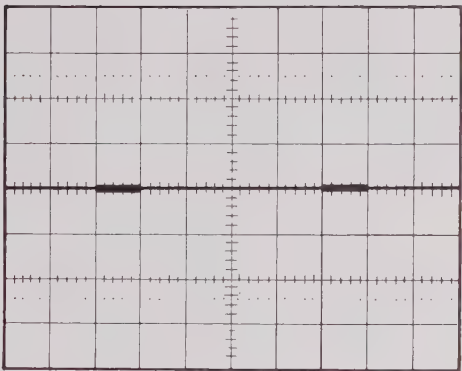


Abb. 1.5. Typische Ablenkempfindlichkeit für externe Triggerung, frequenzabhängig



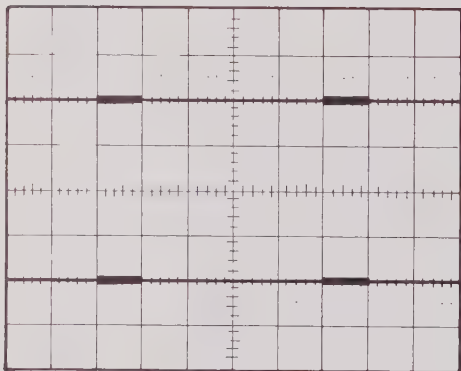
ch. A or ch. B only MA9992

Nur Kanal A oder B



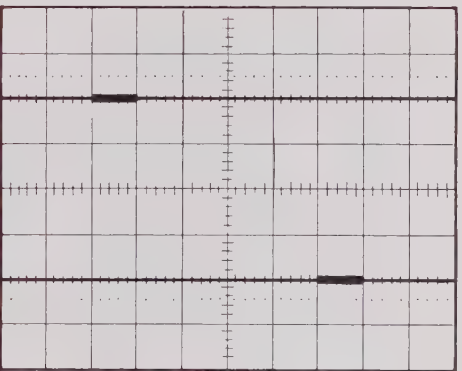
ch. A and ch. B added MA9993

Kanäle A und B addiert



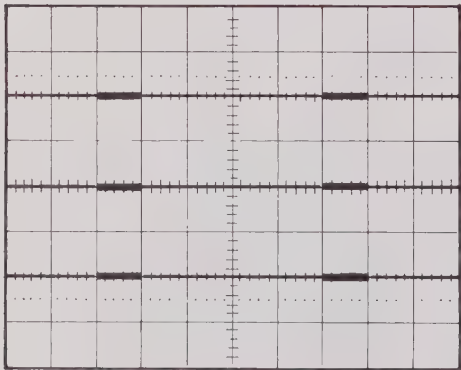
ch. A and ch. B chopped MA9994

Kanäle A und B chopped



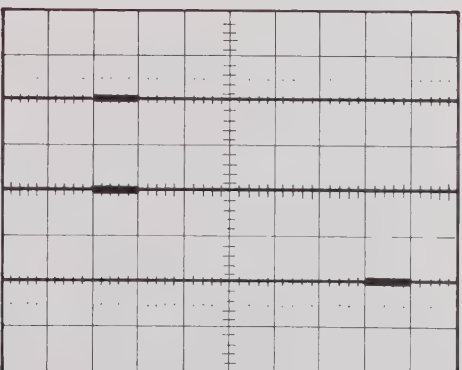
ch. A and ch. B alternated MA9995

Kanäle A und B alternierend



Trigger view, and ch. A and ch. B chopped MA9996

Kanäle A, B und Triggerview chopped



Trigger view, and ch A and ch B alternated MA9997

Kanäle A, B und Triggerview alternierend

Abb. 1.6. Übersicht der verschiedene Darstellungsarten mit doppelte verzögerte Zeitbasis

1.3. MIT DEM INSTRUMENT GELIEFERTES ZUBEHOR

- Zwei 10:1 passive Tastköpfe.
- Kontrastfilter.
- Frontabdeckung mit Platz für die Ablage von Zubehör, z.B. Tastköpfen.
- Zusammenfaltbare Sichtblende PM9366.
- Bananenstecker/BNC-Adapter PM9051.
- CAL-Anschluss/BNC-Adapter.
- Bedienungsanleitung.

1.4. INFORMATION ZU DEN ALS ZUBEHOR GELIEFERTEN 10:1 PASSIVEN TASTKOPFEN

Diese Tastköpfe mit 10-facher Dämpfung sind für Echtzeit-Oszillographen für Frequenzen bis 250 MHz bestimmt und haben einen BNC-Eingangsstecker mit einer Eingangskapazität von $13\text{pF} \pm 3\text{pF}$ parallel zu $1\text{M}\Omega$

1.4.1. Technische Daten

Elektrisch

Abschwächung	10x $\pm 2\%$ (Oszilloskopeingang $1\text{M}\Omega \pm 1\%$)
Einganswiderstand DC AC	10 $\text{M}\Omega \pm 2\%$ (Oszilloskopeingang $1\text{M}\Omega \pm 5\%$) Siehe Kurve, Bild 1.7.
Eingangskapazität DC und NF	11 $\text{pF} \pm 1\text{pF}$ (Oszilloskopeingang $1\text{M}\Omega \pm 5\%$ 13 $\text{pF} \pm 3\text{pF}$)
Eingangsreaktanz HF	Siehe Kurve, Bild 1.7.
Bandbreite	Der Tastkopf hat fast kein Einfluss auf die Bandbreite des Oszilloskopes
Max. Eingangsspannung	500 V DC + AC _{Spitze} , minderend mit Frequenz Oszilloskopeingang $1\text{M}\Omega$ und die zwischen der Tastkopfspitze und dem geerdeten Teil des Tastkopfkörpers angelegte Spannung. Testspannung 1500V, DC über eine Sekunde, bei 15 und 25°C Temperatur und maximal 80% rel. Luftfeuchtigkeit und Meeresspiegelhöhe.
Nullprüfungsknopf Tastkopfgehäuse	Die gleiche Funktion wie der Eingangskopplungs-Schalter des Oszilloskops

Einflussgrößen

Der Tastkopf arbeitet innerhalb der Spezifikationen in folgenden Bereichen:

Temperatur	-25°C bis $+70^{\circ}\text{C}$
Höhe	Bis auf 5000 m (15 000 Fuss)
Ubrige Einflussgrößen	Die gleichen wie geltend für das Oszilloskop mit welchem der Tastkopf verwendet wird.

Mechanisch

Abmessungen

Tastkopfkörper 103 mm x 10 mm ϕ (max)
Kabellänge 1500 mm oder 2500 mm
Kompensationsdose 55 x 30 x 15 mm, einschl. BNC

Masse

125 g einschl. Standardzubehör

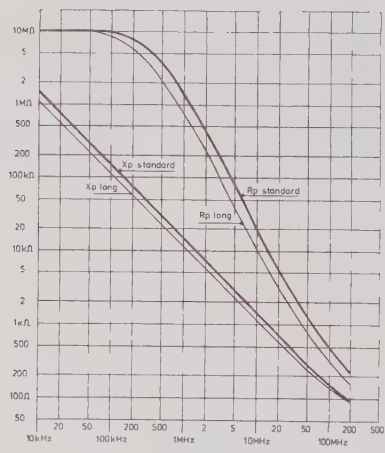


Abb. 1.7. Eingangswiderstand (R_p) und Reaktanz (X_p) gegen Frequenz

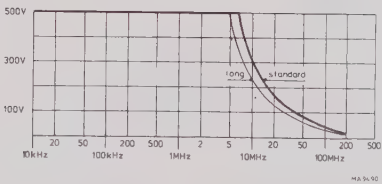


Abb. 1.8. Max. Eingangsspannungsminderung gegen Frequenz

1.4.2. Einstellungen

Anpassen des Tastkopfs an Ihr Oszilloskop

Der Tastkopf wurde vom Hersteller justiert und überprüft. Zur Anpassung des Tastkopfs an das von Ihnen verwendete Oszilloskop sind jedoch nachstehende Handlungen erforderlich.

Den Meszstift mit der CAL Buchse des Oszilloskops verbinden.

Ein Trimmer C2 ist durch eine Öffnung in der Kompensationsdose zugänglich und einstellbar um ein optimales Rechtecksignal zu erlangen; vgl. Bild 1.9b.

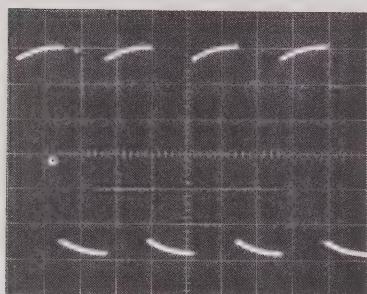


*Bild 1.9.a. Überkompensation
(Einstellung C2)*

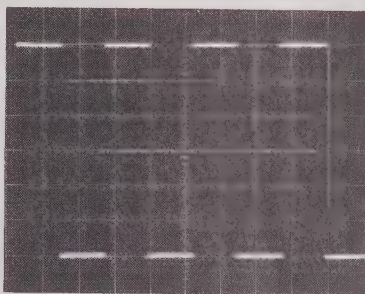


*Bild 1.9.b. Einwandfreie Kompensation
(Einstellung C2)*

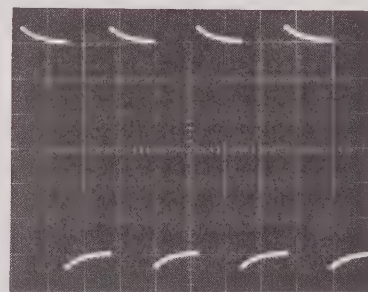


*Bild 1.9.c. Unterkompensation
(Einstellung C2)*

Einstellen des HF Frequenzgang

Die Einstellung des HF Kenlinienkorrektur-Netzwerks zur Anpassung an den Oszilloskopeingang wurde vom Hersteller vorgenommen, so dass Einstellung des HF Kenlinienkorrekturs normalerweise nicht erforderlich ist. Spätere Neueinstellung ist nur dann erforderlich, wenn der Tastkopf mit einem Oszilloskop anderen Typs angewandt wird oder nach dem Ersetzen eines elektrischen Bauteils.

Die Einstellung geschieht wie folgt:

Den Tastkopf an einen schnellen Impulsgenerator (Anstiegszeit nicht über 1 ns), der mit seiner charakteristischen Impedanz abgeschlossen ist, anschliessen. Die Kompensationsdose ausbauen. Den Generator für 100 kHz einstellen. C3, C4, R2, R4 und R5 abwechselnd einstellen bis ein wie in Bild 1.10a veranschaulichtes Oszillogramm erhalten wird.

Wichtig ist, dass die ansteigende Flanke so steil und das obere Teil so flach wie möglich ist. Unrichtige Einstellungen von C3, C4, R2, R4 und R5 führen zu Impulsverzerrungen wie in Bild 1.10.b und 1.10.c ersichtlich.

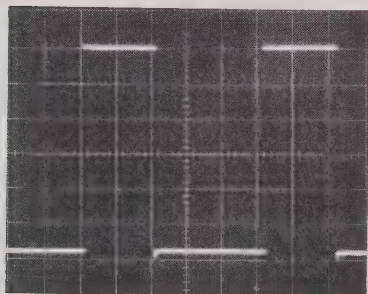


*Bild 1.10.a Voreinstell-Potentiometer
einwandfrei eingestellt*

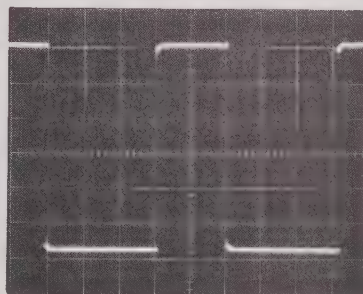


*Bild 1.10.b Rundung als Folge
unrichtig eingestellter
Potentiometer*

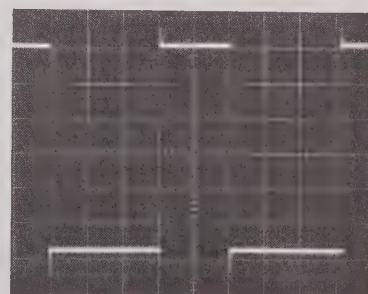


*Bild 1.10.c Überspringen als Folge
unrichtig eingestellter
Potentiometer*

MAT 615

Bezüglich der Lage der Einstellpunkte für C3, C4, R2, R4 und R5 auf der Schaltungsplatine in der Kompensationsdose ist Bild 1.13. zu beachten.

1.4.3. Ausbau

Ausbau des Tastkopfs (Bild 1.11.)

Das vordere Teil des Tastkopfs (11) kann vom rückwärtigen Teil (13) abgeschraubt werden. Pos. 11 lässt sich dann von 12 und 13 entfernen.

Die RC-Kombination (12) ist an 13 festgelötet. Betreffend das Ersetzen von 12 siehe Abschnitt "Ersetzen von Teilen".

Ausbau der Kompensationsdose (Bild 1.11.)

Den gerändelten Kragen zwischen Kompensationsdose und Kabel losschrauben. Das Gehäuse 14 lässt sich nun seitwärts von der Kompensationsdose schieben. Die elektrischen Bauteile auf der Platine sind nun zugänglich.

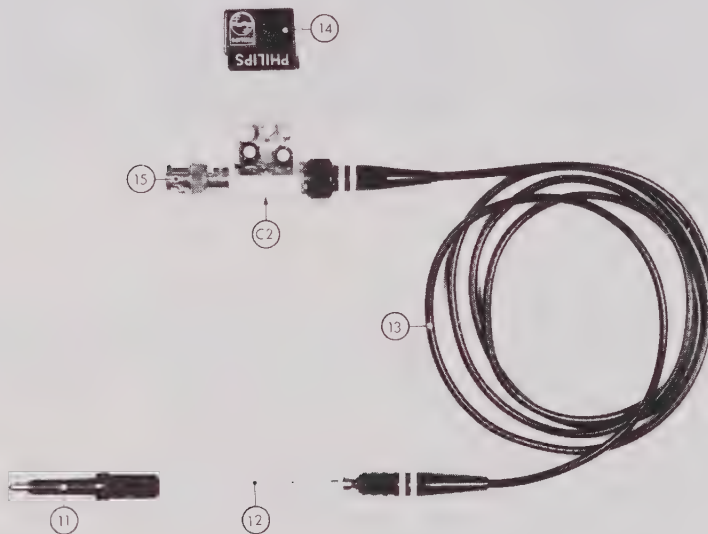


Bild 1.11. Ausbau des Tastkopfs

1.4.4. Ersetzen von Teilen

Zusammenbau des Tastkopfs

Ein neues RC-Netzwerk über das Kabelnippel schieben, danach die Kabelader an den Widerstandsdraht löten. Bei Zusammenbau des Tastkopfes muss das RC-Netzwerk genau in der Mitte der Tastkopfspitze liegen.

Ersetzen der Kabelzusammenstellung

Die Kompensationsdose ausbauen

Die Verbindung zwischen dem Innenleiter und der Platine loslöten. Das Gehäuse der Kompensationsdose festhalten und das Kabelnippel am Sechskantteil mit Hilfe eines 5 mm Schlüssels lösen. Kabel ersetzen und in umgekehrter Arbeitsfolge wieder befestigen.

BNC Ersetzen

Kompensationsdose ausbauen.

Die Verbindung zur Platine loslöten. Die Kompensationsdose festhalten und den BNC mit einem 3/8" Schlüssel lösen. BNC ersetzen und in umgekehrter Arbeitsfolge wieder befestigen.

Ersetzen der Tastkopfspitze

Die beschädigte Spitze mit einer Flachzange herausziehen. Eine neue Spitze muss fest eingedrückt werden.

1.4.5. Ersatzteilliste

1.4.5.1. Mechanische Teile (siehe Bild 1.11. und 1.12.)

Pos. 1 bis 10 sind als Standardzubehör im Lieferumfang des Tastkopfes enthalten.

Pos.	Bestellnummer	Anzahl	Bezeichnung
1	5322 321 20223	1	Erdkabel
2	5322 256 94136	1	Tastkopfhalter
3	5322 255 44026	5	Lötkekmen, die als Routinemesspunkte in Schaltungen einbezogen werden können
4	5322 532 64223	2	Markierungsring, rot
5	5322 532 64224	2	Markierungsring, weiss
	5322 532 64225	2	Markierungsring, blau (nicht abgebildet)
6	5322 268 14017	2	Tastkopfspitzen
7	5322 462 44319	1	Isolierkappe für Abschirmung von Metallteilen des Tastkopfes bei Messungen in dicht verdrahteten Schaltungen
8	5322 462 44318	2	Kappe für Messungen an "Dual in Line" integrierten Schaltungen
9	5322 264 24018	1	Wickelstift (Wrap-pin)-Adapter
10	5322 264 24019	1	Feder-Testklemme
11	5322 264 24021	1	Tastkopfumhüllung mit Nullprüftaste
12	5322 216 54152	1	RC-Netzwerk
13	5322 320 14063	1	Kabel-Zusammenstellung
14	5322 447 64015	1	Abdeckkappe
15	5322 268 44019	1	BNC-Steckverbindung

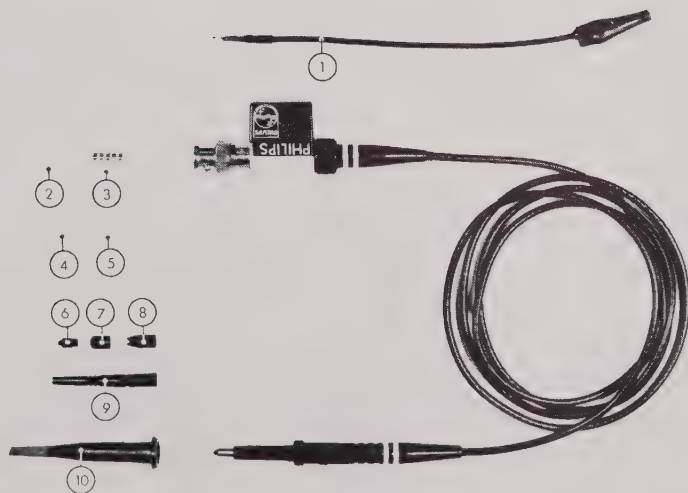


Bild 1.12. Mechanische Teile des Tastkopfes

1.4.5.2. Elektrische Teile (siehe Bild 1.13.)

Pos.	Bestellnummer	Bezeichnung
C1	—	Teil des R.C.-Netzwerks (wird nicht gesondert geliefert)
C2	5322 125 54003	Trimmer 60 pF, 300V
C3	5322 125 50048	Trimmer 3,5 pF, 300V
C4	5322 125 50051	Trimmer 18 pF, 300V
L1	—	Spule (wird nicht geliefert)
R1	—	Teil des R.C.-Netzwerks (wird nicht gesondert geliefert)
R2	5322 100 10135	Potentiometer 470 Ω , 20%
R3	5322 116 50536	Metallschicht Widerstand 464 Ω , 1% , MR25
R4	5322 100 10135	Potentiometer 470 Ω , 20%
R5	5322 100 10143	Potentiometer 1k Ω , 20%

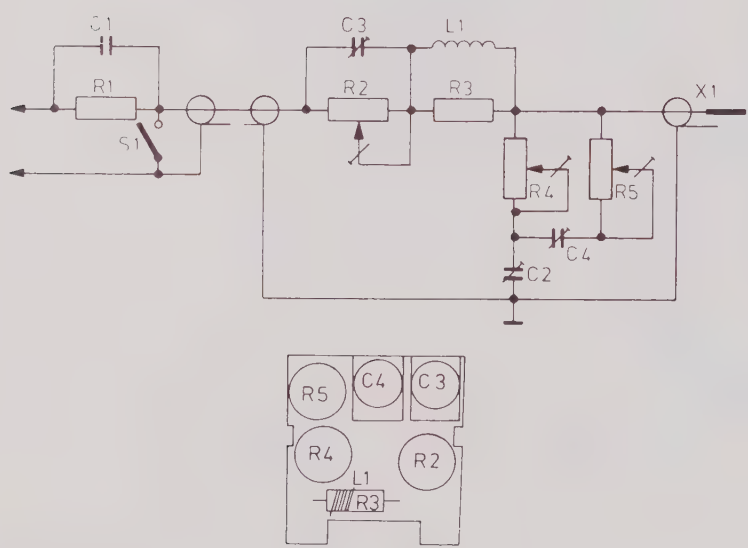


Bild 1.13. Elektrische Teile des Tastkopfs

1.5. BESCHREIBUNG DES FUNKTIONELLEN BLOCKDIAGRAMS

1.5.1. Vertikal-Ablenkung

Das Gerät besitzt zwei identische Kanäle A und B, für die jeweils für die Signale an den Eingängen A und B eine Signalkontrolle und -verstärkung möglich ist. Der Einfachheit halber erfolgt lediglich eine Beschreibung für den Kanal A.

Der Kanal A besitzt einen Eingangssignal–Kopplungsschalter AC/O/DC, einen Schalter AMPL/DIV zur Einstellung der Signalverstärkung bzw. des vertikalen Ablenk-Koeffizienten und einen Einsteller POSITION, der mit einem Zug-Druck-Schalter NORMAL/INVERT zusammengefasst ist. Bei den drei Schaltstellungen des Schalters AC/O/DC wird das Eingangssignal in der Schaltstellung AC an den Verstärkereingang über einen Gleichspannungsblockierkondensator angelegt; in der Schaltstellung O wird das Eingangssignal unterbrochen und in der Schaltstellung DC wird das Signal direkt an den Verstärkereingang angelegt. Der Einsteller POSITION ist ein Potentiometer, durch dessen Verdrehen eine kontinuierliche Vertikal-Verschiebung des Signals auf dem Bildschirm herbeiführbar ist. Durch Drücken bzw. Ziehen an dem Einsteller POSITION besteht ausserdem die Möglichkeit, das Signal "NORMAL" oder "INVERTIERT" darzustellen.

Das Triggern der Zeitbasis für ein von einem der Vertikal-Kanäle abgeleitetes Signal ist über den Block A/B/ COMPOSITE TRIGGER SWITCHING möglich.

Mit dem Schalter VERTICAL CHANNEL ist es möglich, das Ausgangssignal des Kanals A zu der Verzögerungsleitung (DELAY LINE) und zu dem Endverstärker für die Vertikalablenkung (FINAL VERTICAL AMPLIFIER) durchzuschalten oder das Signal zu blockieren. Andere Signalquellen für die Verzögerungsleitung und den Endverstärker sind die Ausgangssignale des Kanals B oder des Blocks TRIGGER VIEW AMPLIFIER. Dieses Signal ist das Triggersignal für den Haupttakt und stammt aus der Haupttakt-Triggerquelle. Wenn die Kanäle A und B gleichzeitig durchgeschaltet sind, werden die Ausgangssignale dieser Kanäle addiert und auf dem Bildschirm erfolgt eine Darstellung des Summensignals. Der Schalter VERTICAL CHANNEL wird von der VERTICAL DISPLAY MODE LOGIC gesteuert, die ihrerseits von der Einstellung der vertikalen Darstellungsart A, ALT, TRIG VIEW, CHOP, ADD, B gesteuert wird. Wenn mehr als ein Kanal dargestellt wird, dann kann die Anzeige in den Funktionen CHOPped oder ALTerate erfolgen, d.h. zerhackt oder alternierend. Für die alternierende Darstellung wird dabei ein von der Hauptzeitbasis (MAIN TIME BASE) abgeleitetes Signal verwendet.

Die Verzögerungsleitung (DELAY LINE) sorgt für die erforderliche Signalverzögerung, so dass die Vorderflanke eines schnellen Signalphänomens auf dem Bildschirm dargestellt werden kann.

Der Endverstärker für die Vertikalablenkung (FINAL VERTICAL AMPLIFIER) dient der Ansteuerung der Vertikal-Ablenkplatten der Elektronenstrahlröhre. Bei der Betriebsart mit alternierendem Takt ermöglicht die TRACE SEPARation-Steuerung eine unterschiedliche Einstellung der Vertikalablenkung für das Hauptzeitbasis-signal und das verzögerte Zeitbasissignal zum Erleichtern eines Vergleichs.

1.5.2. Horizontal-Ablenkung

Als Signalquelle für den Endverstärker für die Horizontal-Ablenkung (FINAL HORIZONTAL AMPLIFIER) können die Hauptzeitbasis (MAIN TIME BASE), die verzögerte Zeitbasis (DELAYED TIME BASE) und das Ausgangssignal des Horizontal-Ablenkverstärkers (HORIZONTAL DEFLECTION AMPLIFIER) ausgewählt werden.

Die Wahl der Signalquelle erfolgt über den Horizontal-Kanalschalter (HORIZONTAL CHANNEL SWITCH), der seinerseits durch die Logik zur Wahl der horizontalen Darstellungsart (HORIZONTAL DISPLAY MODE LOGIC) gesteuert wird, welche ihrerseits durch die Einstelleinrichtungen für die horizontale Betriebsart mit dem Schaltmöglichkeiten DELD TB, ALT TB, EXT X DEFL und MAIN TB.

Sowohl die Hauptzeitbasis wie auch die verzögerte Zeitbasis können eine zeitlineare Sägezahnspannung erzeugen, deren Anstiegszeit mit Hilfe eines Einstellers TIME/DIV einstellbar ist.

Hauptzeitbasis-Triggerquelle/Filter/Triggerverstärker:

Die Hauptzeitbasis kann durch die Kanäle A oder B, durch ein mit der Netzspannung verknüpfted Signal aus dem Netzteil oder durch ein an den externen Triggereingang EXT TRIG OR X DEFL angelegtes Signal getriggert werden. Die gewünschte Triggerquelle kann durch Schalter für den Block TRIGGER SOURCE ausgewählt werden. Das ausgewählte Triggerquellensignal kann mit einem Niederfrequenzfilter oder einem Hochfrequenzfilter gefiltert oder, wenn die DC-Taste des DC/LF/HF-Einstellers gedrückt ist, ungefiltert zugeführt werden. Der Pegel und die Steigung mit der die Hauptzeitbasis anläuft, können durch den Einsteller LEVEL/SLOPE vorgegeben werden. Die ausgewählte Hauptzeitbasis-Triggerquelle kann auch für den Horizontal-Ablenkverstärker und über den Vertikal-Kanalschalter für die Einheit TRIGGER VIEW verwendet werden.

Wenn die Betriebsart "Ereignisse vor der Hauptzeitbasis" (EVENTS BEFORE MTB) ausgewählt wird, dann wird der Start der Hauptzeitbasis durch ein Signal vom Ereigniszähler (EVENT COUNTER) eingeleitet. Vgl. Abschnitt 1.5.3.

Triggerquelle für verzögerte Zeitbasis/Filter/Triggerverstärker: die verzögerte Zeitbasis kann durch die Kanäle A oder B oder durch ein an einen externen Triggereingang EXT TRIG angelegtes Signal getriggert werden. Die Signalkopplung DC/LF/HF und die Größen LEVEL/SLOPE sind einstellbar.

In dem Block mit der Bezeichnung COMPARATOR wird der Sägezahn der Hauptzeitbasis mit einer einstellbaren Gleichspannung von einem dualen Digital/Analog-Umsetzer verglichen. Dies geschieht in den Betriebsarten DELAY und ΔT .

(Einzelheiten siehe Abschnitt 1.5.3.).

In dem Moment, in dem die Sägezahnspannung dem eingestellten Gleichspannungspegel entspricht, liefert der Komparator ein Signal an die verzögerte Zeitbasis. Wenn die Drucktaste MAIN TB der Triggerquellen-Einstell-einrichtung gedrückt wird, beginnt nun sofort die verzögerte Zeitbasis. Wenn die Drucktaste A, B oder EXT der Triggerquellen-Wähleinrichtung gedrückt wird, beginnt die verzögerte Zeitbasis nach dem Ausgangssignal des Komparators beim Eintreffen eines Triggerimpulses aus der ausgewählten Triggerquelle.

Wenn die Betriebsart "Ereignisse vor verzögerte Zeitbasis" gewählt ist und eine der Drucktasten A, B oder EXT der Triggerquellen-Wähleinrichtung für die verzögerte Zeitbasis gedrückt wird, dann wird die verzögerte Zeitbasis durch ein Signal aus dem Ereigniszähler eingeleitet. Vgl. 1.5.3.

1.5.3. Verzögerung und Ereigniszählerbereich

Das Herzstück dieses Bereichs des Gerätes wird durch den Mikrocomputer gebildet. Dieser Block tastet nacheinander die Einstellungen der Einstellorgane an der Frontplatte des Geräts ab. Dies geschieht über die Eingangsschnittstelle (INPUT INTERFACE). In Abhängigkeit von der Einstellung der Einstellorgane kann der Mikrocomputer eine Anzahl von mit ihm verbundener Blöcke aktivieren.

Zuallererst stellt der Mikrocomputer die Leuchtdiodenanzeige (LED DISPLAY) auf die Werte und Funktionen ein, die an den Einstellorganen der Frontplatte eingestellt wurden. Dabei wird auch angezeigt, wenn die Einstellorgane bzw. Bedienungselemente eine unzulässige Einstellung aufweisen.

In der Betriebsart "Verzögern" (DELAY) steuert der Mikrocomputer den dualen D/A-Umsetzer (DUAL DIGITAL TO ANALOG CONVERTER). Dieser Umsetzer erzeugt ausgangsseitig eine Gleichspannung, die an den in Abschnitt 1.5.2. beschriebenen Komparator angelegt wird. Der Mikrocomputer steuert den Umsetzer derart, dass der von der Leuchtdiodenanzeige angezeigte Verzögerungswert der tatsächlichen Verzögerung zwischen dem Start der Hauptzeitbasis und dem Start der verzögerten Zeitbasis entspricht.

In den Betriebsarten DELAY und ΔT empfängt der Komparator alternierend zwei verschiedene Gleichspannungen von dem Umsetzer.

- Während einer Phase der Hauptzeitbasis wird eine Gleichspannung an den Komparator angelegt, welche nach der eingestellten Verzögerungszeit zum Start einer verzögerten Zeitbasis führt.
- Während der nächsten Phase der Hauptzeitbasis wird an den Komparator eine etwas höhere Gleichspannung angelegt, die zu einem Beginn der verzögerten Zeitbasis nach Ablauf der Verzögerungszeit zuzüglich eines Zeitintervalls ΔT führt.

Die Anzeige zeigt nunmehr den Wert für die ΔT -Zeit. Wenn die Drucktaste 1/T gedrückt wird, berechnet der Mikrocomputer den Wert $1/\Delta T$ und sorgt dafür, dass dieser Wert von der Anzeige angezeigt wird.

In den Betriebsarten "Ereignisse vor Hauptzeitbasis" oder "Ereignisse vor verzögerte Zeitbasis" arbeitet der Ereigniszähler (EVENT COUNTER). Nunmehr wird die Anzahl der Ereignisse bezogen auf die Anzahl der Impulse aus der Triggerquelle für die verzögerte Zeitbasis in dem Ereigniszähler gezählt. Wenn eine vorgegebene Anzahl von Ereignissen gezählt wurde, startet der Ereigniszähler die Hauptzeitbasis (in der Betriebsart "Ereignisse vor Hauptzeitbasis") oder die verzögerte Zeitbasis (in der Betriebsart "Ereignisse vor verzögerte Zeitbasis"). Der Mikrocomputer steuert den Ereigniszähler und die Leuchtdiodenanzeige so, dass die Hauptzeitbasis oder die verzögerte Zeitbasis nach der angezeigten Anzahl von Ereignissen beginnt.

1.5.4. Verzögerungsbereich der Elektronenstrahlröhre

Der Z-Verstärker empfängt fünf Eingangssignale, die die Intensität des Punktes auf dem Bildschirm bestimmen. Diese Intensität wird über den "Wehnelt Zylinder" der Kathodenstrahlröhre (CRT) gesteuert. Ausser der Intensität wird auch die Fokussierung des Punktes auf dem Bildschirm korrigiert. Die Fokussierung des Punktes auf dem Bildschirm ändert sich folglich nicht in Abhängigkeit von Änderungen der Intensität.

Im einzelnen werden die Intensität und die Fokussierung durch folgende Signale gesteuert:

- Die Einstellung des Einstellers INTENS an der Frontplatte.
- Ein Austastsignal aus der Einheit VERTICAL DISPLAY MODE LOGIC für die Betriebsart "zerhackte Darstellung".
- Ein Signal für das Austasten der Anzeige während der hold-off-Periode der Hauptzeitbasis. Dieses Signal stammt aus dem Block Hauptzeitbasis.
- Ein Signal welches aus dem Horizontal-Kanalschalter für den verstärkten Teil des verzögerten Zeitbasis-signals auf dem Hauptzeitbasissignal geliefert wird.
- Ein externes Signal, welches an die Eingangsfassung Z-MOD angelegt werden kann.

1.5.5. Netzteil

Das Netzteil ist stabilisiert und erzeugt die Versorgungsgleichspannungen für die elektronischen Schaltkreise des Geräts, die hohe positive Spannung für den ersten Beschleuniger der Elektronenstrahlröhre und die hohe negative Spannung für die Kathode derselben.

Ausserdem liefert der Netzteil ein mit der Netzspannung verknüpftes Signal zum Triggern der Hauptzeitbasis.

2. INSTALLIERUNGSANLEITUNGEN

2.1. WICHTIGE SICHERHEITSBEDINGUNGEN (DEN IEC 348 VORSCHRIFTEN ENTSPRECHEND)

Vor Anschluss des Geräts an das Netz ist eine Sichtkontrolle vorzunehmen, um eine mögliche Beschädigung des Geräts während des Transports feststellen zu können. Wenn irgendwelche Defekte wahrgenommen werden, darf das Gerät **nicht** an das Netz angeschlossen werden.

REKLAMATIONEN: Im Falle offensichtlicher Beschädigungen oder Mängel oder wenn der sicherheits-technische Zustand zweifelhaft erscheint, muss beim Überbringer sofort reklamiert werden. Eine Philips Verkaufs- oder Servicestelle muss ebenfalls verständigt werden um Reparatur des Geräts zu ermöglichen.

Vor dem Anschliessen muss der Erdschutzanschluss mit einem Schutzleiter verbunden werden (siehe 2.4. "Erdung").

WARNUNG: Beim Öffnen von Abdeckungen oder Entfernen von Teilen mit Werkzeug können spannungsführende Teile freigelegt werden. Auch können Anschlussstellen spannungsführend und somit Lebensgefährlich sein.

Vor dem Öffnen des Geräts muss das Gerät von allen Spannungsquellen getrennt sein.

Wenn danach eine Kalibrierung, Wartung oder Reparatur am geöffneten Gerät unter Spannung unvermeidlich ist, so darf das nur durch eine Fachkraft geschehen, welche die damit verbundene Gefahren kennt.

Kondensatoren im Gerät können noch geladen sein, selbst wenn das Gerät von allen Spannungsquellen getrennt wurde, die Schaltbilder sind zu beachten.

2.2. ABNEHMEN UND AUFSETZEN DER FRONT-ABDECKHAUBE (siehe Bild 2.1.)

Abnehmen

- Den Knopf in der Mitte des Deckels eindrücken und eine viertel Umdrehung nach links drehen (Stellung UNLOCKED).
- Deckel abnehmen.

Aufsetzen

- Den Verriegelungsknopf eindrücken und in Stellung UNLOCKED drehen.
- Deckel an der Vorderseite des Oszillografen befestigen.
- Knopf eindrücken und eine viertel Umdrehung nach rechts drehen (Stellung LOCKED).

2.3. BETRIEBSLAGE DES GERÄTS

Das Gerät darf in beliebiger Lage betrieben werden. Mit dem Tragbügel nach unten geschwenkt kann das Gerät in Schrägstellung benutzt werden. Die elektrischen Kenndaten nach Abschnitt 1.2. sind für jede Betriebslage des Geräts garantiert. Es ist darauf zu achten, dass die Deckel- und Bodenabdeckung frei sind. Das Gerät nie auf eine Wärme erzeugende oder ausstrahlende Oberfläche stellen oder direkter Sonneneinstrahlung aussetzen.

Der Tragbügel lässt sich drehen, wenn die Lagerzapfenknöpfe eingedrückt werden.



Abb. 2.1. Abnehmen der Abdeckhaube

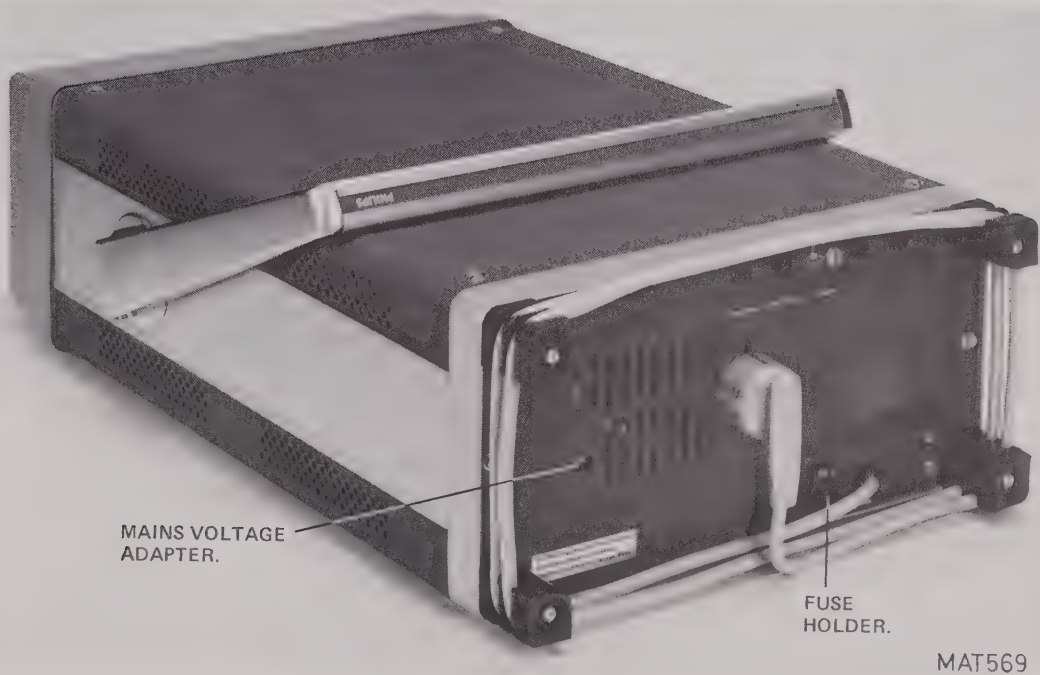


Abb. 2.2. Rückansicht des Geräts

2.4. ERDUNG

Vor dem Einschalten muss das Gerät auf eine der folgenden Weisen mit einem Erdschutzleiter verbunden werden:

- über den Schutzerdeanschluss;
- über das dreiadrige Netzkabel. Der Netzstecker darf nur in eine Schutzkontaktdose eingeführt werden. Die Schutzmassnahme darf nicht unwirksam gemacht werden, z.B. durch eine Verlängerungsleitung ohne Schutzleiter.

WARNUNG: Jede Unterbrechung des Schutzleiters innerhalb oder ausserhalb des Geräts oder Trennung vom Schutzerdeanschluss ist gefährlich und deshalb unzulässig.

Wenn ein Gerät von kalter in warme Umgebung gebracht wird, kann durch Kondensation ein sicherheitstechnisch gefährlicher Zustand entstehen. Deshalb sind die Erdungsvorschriften genauestens zu beachten.

2.5. EINSTELLEN DER NETZSPANNUNG UND SICHERUNG

Vor Einführen des Netzsteckers in die Netzbuchse ist zu kontrollieren ob das Gerät für die örtliche Netzspannung eingestellt ist.

Das Gerät ist bei zwei Netzspannungsbereichen betriebsfähig nämlich: 100 ... 127 V Wechselspannung ($\pm 10\%$) und 220 ... 240 V Wechselspannung ($\pm 10\%$).

Letzter Spannungsbereich wird auch angewandt wenn das Gerät mit einer Gleichspannung zwischen 250 und 300 V betrieben wird. Jeder der beiden Spannungsbereiche ist mit Hilfe des Spannungsschalters, welcher sich hinter dem Fenster an der Geräterückseite befindet, einstellbar. Der gewählte Spannungsbereich ist durch das Fenster sichtbar (siehe Bild 2.2.).

Bevor man Zugang zum Spannungsumschalter erlangen will, muss das Gerät von allen Spannungsquellen getrennt sein. Der Schalter wird nach Abnahme der Geräterückwand zugänglich (die beiden Schrauben lösen). Das Gerät ist gegen unrichtige Einstellung des Spannungsumschalters geschützt.

Der an der Rückwand angebrachte Sicherungshalter enthält eine Sicherung, 2 A, träge.

Es dürfen nur die vorgeschriebenen Sicherungen verwendet werden. Die Verwendung reparierter Sicherungen und das Kurzschliessen des Sicherungshalter sind nicht zulässig. Das Gerät muss von allen Spannungsquellen getrennt sein wenn eine Sicherung ersetzt wird.

Es dürfen nur Sicherungen des vorgeschriebenen Wertes und Typs verwendet werden. Verwendung reparierter Sicherungen und Kurzschliessen des Sicherungshalter ist nicht zulässig. Beim Ersetzen von Sicherungen oder beim Umschalten auf eine andere Netzspannung muss das Gerät von allen Spannungsquellen getrennt sein.

3. BETRIEBSANLEITUNG

3.1. ALLGEMEINES

Dieser Abschnitt gibt einen Überblick der für die Inbetriebnahme des Geräts erforderlichen Handlungen und Vorsichtmassregeln. Er beschreibt und erläutert in Kürze die Funktion der Bedienungsorgane auf Frontplatte und Rückwand sowie der Anzeigen. Ausserdem sind hier die praktischen Gesichtspunkte der Bedienung erklärt, dies ermöglicht dem Bedienungsmann eine rasche Bewertung der Hauptfunktionen des Geräts.

3.2. EINSCHALTUNG

Nach dem Anschluss des Oszilloskops an das Netz, gemäss Abschn. 2.4. und 2.5., kann es mit Schalter **POWER** eingeschaltet werden.

Der Schalter **POWER** (Netzschalter) ist gekoppelt an **ILLUM** auf der Frontplatte unter dem Bildröhrenrahmen. Die zugehörige **POWER ON/OFF** Anzeigelampe befindet sich neben dem **ILLUM/POWER** Schalter.

Das Oszilloskop ist sofort nach Einschaltung betriebsfähig. Bei normaler Installation nach Abschnitt 2 und nach 30 Minuten Anwärmzeit gelten die Abschnitt 1.2. gegebenen Kenndaten.

WARNUNG: Das Oszilloskop darf niemals eingeschaltet werden, wenn eine Leiterplatte entfernt (ausser IEC und Ersatzplatine).
Eine Leiterplatte immer erst dann entfernen, wenn das Oszilloskop zumindest eine Minute ausgeschaltet ist.

3.3. EINSCHALTTEST

Bei Einschaltung löst der Mikroprozessor einen automatischen Test der internen Schaltungen einschliesslich

- Prozessor Test
- PROM Test
- RAM Test
- LED-Anzeige Test, aus.

Die Testergebnisse erscheinen auf der LED-Anzeige.

Während 0,5 Sek. erscheint von links nach rechts auf jeder Ziffer eine 

Hiernach leuchten die EV, DIV und S oder Hz Lampe 0,5 Sek. lang auf.

Falls die vom Mikroprozessor gesteuerten Schaltungen nicht einwandfrei funktionieren dann erscheinen auf der LED-Anzeige folgende Testergebnisse:

- Die LED-Anzeige bleibt dunkel.
- Prozessor wahrscheinliche Ursache:
- Eine  in der Ziffer äusserst rechts:
PROM wahrscheinliche Ursache.
- Eine / in der Ziffer äusserst rechts:
RAM wahrscheinliche Ursache.

Keine der Tasten eingedrückt	Wird keine Taste eingedrückt ist die Betriebsweise des Gerätes wie bei Einstellung ALT.
— Lageeinstellung und Invertierung	
POSITION	Stufenlose Einstellung der vertikalen Lage des Bildes
PULL TO INVERT	Zweiweg Zug-Druckschalter gekoppelt an Einsteller POSITION zur Umkehrung der Signalpolarität. Eindrücken für NORMAL ziehen für INVERT.
AMPL/DIV	Stufenweise Einstellung der Vertikalablenkkoeffizienten mit 11 Stellungen. In Lage 2 mV/Teil ist die Bandbreite auf 35 MHz begrenzt.
CAL (AMPL/DIV)	Stufenlose Einstellung der Vertikalablenkkoeffizienten. In Stellung CAL ist der eingestellte Ablenkkoeffizient kalibriert.
UNCAL	Lampenanzeige warnt dass sich der Einsteller CAL nicht in Kalibrierstellung befindet.
GAIN (Schraubenziehereinstellung)	Kalibrierung der Verstärkung in Stellung CAL.
— Y-Eingangskopplung	
AC, 0, DC	Signalkopplung. Drehschalter mit 3 Stellungen.
AC	Kopplung über einen Sperrkondensator.
0	Verbindung zwischen Eingangsschaltung und Eingangsbuchse wird unterbrochen und der Verstärkereingang geerdet.
DC	Direkte Kopplung.
— Eingang	
A 1 MOhm - 15 pF	BNC Eingangsbuchse für Kanal A
B 1 MOhm - 15 pF	BNC Eingangsbuchse für Kanal B
ELEKTRONENSTRAHLRÖHRE	
CAL	Ausgang der eine 3 Vs-s, 2 kHz Rechteckspannung zur Kalibrierung des Vertikalablenkungs-Steller CAL oder für die Frequenzkompensation von Spannungsleiter-Tastköpfen zur Verfügung stellt. Stromschlinge mit 6 mAs-s für die Kalibrierung von Strommessköpfen.
POWER, ILLUM	Stufenlose Einstellung der Rasterbeleuchtung zugleich Netzschalter (ON/OFF).
POWER ON	Signallampe zeigt an dass der Netzschalter eingeschaltet ist.
TRACE ROT (Schraubenziehereinstellung)	Voreinstellung zur Ausrichtung der Leuchtspur mit den Rasterlinien.
INTENS	Stufenlose Einstellung der Bildhelligkeit.
FOCUS	Stufenlose Einstellung zur Fokussierung des Elektronenstrahls.

3.4.2. Horizontalablenkung

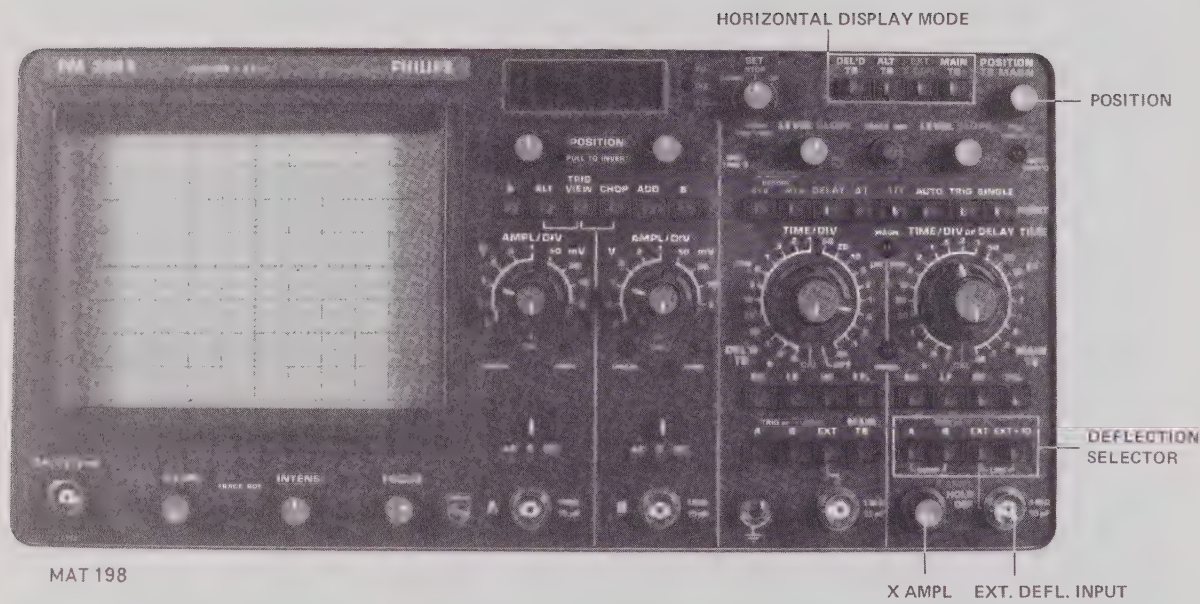


Abb. 3.2. Horizontalablenkung

– Horizontale Darstellungsart DEL'D TB eingedrückt	Wählt die gewünschte Horizontalablenkung. Die Horizontalablenkspannung wird vom verzögerten Zeitablenk- generator geliefert.
ALT TB eingedrückt	Die horizontale Darstellung wird am Ende jedes Sägezahn von der Hauptzeitablenkung auf verzögerte Zeitablenkung umgeschaltet und so weiter.
EXT X DEFL eingedrückt	Wenn ALT TB kombiniert wird mit TRIG VIEW, wird MAIN TB mit aufgeheltem DEL'D TB dargestellt.
MAIN TB eingedrückt	Horizontalablenkung durch ein an die Eingangsbuchse des Horizontalverstärkers gelegtes Signal, durch ein von Kanal A oder B kommendes Signal, oder ein Netzfrequenzsignal, je nach Einstellung von TRIG oder X DEFL.
Keine Tasten eingedrückt	Horizontalablenkspannung wird vom Hauptzeitablenkgenerator geliefert; ein Teil der Darstellung wird aufgehellt (Ausgenommen in Stellung OFF des TIME/DIV Schalters des verzögerten Zeit- ablenkgenerators).
– POSITION (TB MAGN)	Die gleiche Wirkung wie MAIN TB gedrückt.
TRACE SEP.	Stufenlose Einstellung der horizontalen Lage des Bildes; gekoppelt mit einem Zug-Druck-Schalter der den Horizontalablenkcoeffi- zienten 10 mal steigert (PULL FOR X10).
	Stufenlose regelbare Einstellung des vertikalen Abstands zwischen den beiden Zeitablenkungs-Darstellungen in Betriebsart ALT TB.

- Ablenkungswähler
 - A gedrückt
X-Ablenkung intern von Kanal A.
 - B gedrückt
X-Ablenkung intern von Kanal B.
 - EXT gedrückt
Das Signal am externen Eingang wird für X-Ablenkung benutzt.
 - EXT ÷ 10 gedrückt
Gleich wie oben, jedoch über einen eingebauten 1:10 Spannungsteiler.
 - LINE (EXT und EXT ÷ 10 gedrückt)
X-Ablenkung intern von der Netzspannung.
- EXT DEFL INPUT
Eingangsbuchse für externe X-Ablenkung.
- X AMPL
Stufenlose Einstellung der X-Ablenkungs Amplitude, kombiniert mit Knopf HOLD OFF. Normalerweise steht dieser Knopf auf CAL.

3.4.3. Hauptzeitbasis

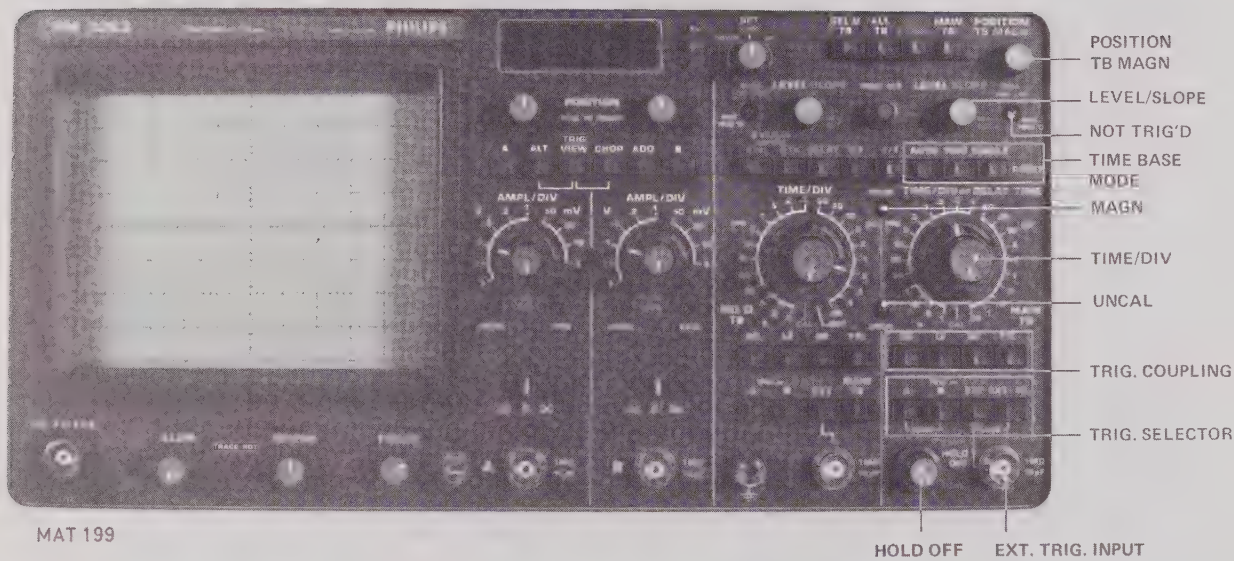


Abb. 3.3. Hauptzeitbasis

TB MAGN

Zug-Druckschalter der den Horizontalablenkkoeffizienten um einen Faktor 10 steigert (PULL FOR X10).

LEVEL-SLOPE

Stufenlose Einstellung des Triggersignalpegels bei welchem der Zeitablenkgenerator startet. Diese Einstellung ist gekoppelt mit einem Zug-Druck-Schalter zur Triggerungswahl auf der positiv oder negativ gerichteten Flanke des Triggersignals (gedrückt "+", gezogen "-").

NOT TRIG'D

Signallampe leuchtet auf wenn die Zeitablenkung nicht getriggert ist, z.B. bei Wartestellung.

- AUTO, TRIG, SINGLE
- AUTO eingedrückt
- TRIG eingedrückt
- SINGLE, RESET

Triggerart-Einstellungen; Drucktastenschalter mit 3 Stellungen. Liegt kein Triggersignal an so läuft die Hauptzeitbasis frei. Der Zeitablenkgenerator wird auf normale Weise getriggert. Eindrücken dieser Taste schaltet einmalige Ablenkung der Hauptzeitbasis ein. Nach Empfang eines Triggersignals läuft die Hauptzeitbasis nur einmal ab. Durch nochmaliges Eindrücken dieser Taste wird die Hauptzeitbasis rückgestellt und ist bereit für den nächsten Triggerimpuls.

Wenn keine Taste eingedrückt ist arbeitet die Schaltung wie in Betriebsart SINGLE.

– MAGN

Signallampe anzeigend dass die 10-fache Dehnung eingeschaltet ist; gilt sowohl für Hauptzeitbasis wie auch für die verzögerte Zeitbasis

– TIME/DIV

Einstellung des Zeitkoeffizienten der Hauptzeitbasis Drehschalter mit 23 Stellungen.

CAL (blau) - TIME DIV	Stufenlose Einstellung des Zeitkoeffizienten der Hauptzeitbasis In Stellung CAL ist der Zeitkoeffizient kalibriert.
UNCAL	Signallampe zeigt an dass sich Einsteller CAL nicht in Kalibrier- einstellung befindet, dies gilt sowohl für die Hauptzeitbasis wie für die verzögerte Zeitbasis.
— TRIG COUPLING	4-Stellungs Drucktastenschalter.
DC eingedrückt	Gesamte Trigger-Bandbreite (einschliesslich DC)
LF eingedrückt	Kopplung über Tiefpass von DC bis 30 kHz (für externe Triggerung über einen Bandfilter von 7 Hz bis 30 kHz).
HF eingedrückt	Kopplung über Hochpass für Frequenzen über 30 kHz.
TTL eingedrückt	Triggerung auf TTL Pegel Pegeleinsteller unwirksam.
Keine Drucktaste eingedrückt	Die Schaltung arbeitet wie mit Taste DC gedrückt.
— TRIG SELECTOR	4-Stellungs Drucktastenschalter.
A eingedrückt	Interne Triggerung auf Kanal A
B eingedrückt	Interne Triggerung auf Kanal B.
COMP (A und B gedrückt)	Interne Triggerung auf Kanälen A und B. Nur im Y alternierend Betrieb.
EXT eingedrückt	Triggerung auf externes Signal über angrenzende EXT TRIG INPUT Buchse.
EXT ÷10 gedrückt	Gleich wie voriges, jedoch über einen eingebauten 1:10 Spannungs- teiler.
LINE (EXT und EXT ÷ 10 gedrückt)	Triggerung intern von Netzspannung.
EXT TRIG INPUT	Eingang für externe Triggerung.
— HOLD OFF	Dieser Knopf ermöglicht Einstellung der Sperrzeit der Hauptzeit- basis und gestattet perfekte Triggerung von beispielsweise Doppelimpulssignalen. Normalerweise steht dieser Knopf auf CAL. Drehen des Knopfes aus Stellung CAL hinweg erhöht die Sperr- zeit. Kombiniert mit stufenlosem Einsteller X AMPL.

3.4.4. Verzögerte Zeitbasis



Abb. 3.4. Verzögerte Zeitbasis

POSITION TB MAGN	Stufenlose Einstellung der horizontalen Lage des Bildes; gekoppelt mit einem Zug-Druckschalter der den Horizontalablenkoeffizienten um einen Faktor 10 erhöht (PULL FOR X10).
TRACE SEP.	Stufenlos regelbare Voreinstellung des Abstand zwischen den beiden Zeitbasis-Darstellungen in Betriebsart ALT TB.
LEVEL-SLOPE	Stufenlose Einstellung des Triggersignalpegels bei welchem der Zeitablenkgenerator startet. Diese Einstellung ist gekoppelt mit einem Zug-Druck-Schalter zur Triggerungswahl auf der positiv oder negativ gerichteten Flanke des Triggersignales. (gedrückt "+", gezogen "-").
NOT TRIG'D	Signallampe leuchtet auf wenn die Zeitablenkung nicht getriggert ist, z.B. bei Wartestellung.
MAGN	Signallampe gibt an dass die X10 Dehnung wirksam ist, gilt sowohl für verzögerte Zeitbasis wie Hauptzeitbasis.
TIME/DIV	Einstellung des Zeitkoeffizienten der verzögerten Zeitbasis Drehschalter mit 23 Stellungen. In Stellung OFF wird die verzögerte Zeitbasis abgeschaltet.
CAL (blau) - TIME/DIV	Stufenlose Einstellung des Zeitkoeffizienten der verzögerten Zeitbasis. In Stellung CAL ist der Zeitkoeffizient kalibriert.
UNCAL	Signallampe zeigt an dass sich Einsteller CAL nicht in Kalibrierstellung befindet.

— TRIG COUPLING	4-Stellungs Drucktastenschalter
DC eingedrückt	Gesamte Trigger-Bandbreite (einschliesslich DC)
LF eingedrückt	Kopplung über Tiefpass von DC bis 30 kHz (für externe Triggerung über einen Bandfilter von 10 Hz bis 30 kHz).
HF eingedrückt	Kopplung über Hochpass für Frequenzen über 30 kHz.
TTL eingedrückt	Triggerung auf TTL Pegel.
Keine Drucktaste eingedrückt	Pegeleinsteller unwirksam.
	Die Schaltung arbeitet wie mit eingedrückter Taste DC.
— TRIG SELECTOR	4-Stellungs Drucktastenschalter.
A eingedrückt	Interne Triggerung auf Kanal A nach Verzögerungszeit.
B eingedrückt	Interne Triggerung auf Kanal B nach Verzögerungszeit.
EXT eingedrückt	Triggerung auf externes Signal nach Verzögerungszeit über angrenzende Buchse EXT TRIG INPUT.
MAIN TB gedrückt	Verzögerte Zeitbasis startet sofort nach Verzögerungszeit. Wenn keine Taste gedrückt ist, arbeitet die Schaltung wie mit eingedrücktem Knopf A.
— EXT TRIG INPUT	Eingang für externe Triggerung

3.4.5. Ereigniszählung und Verzögerung

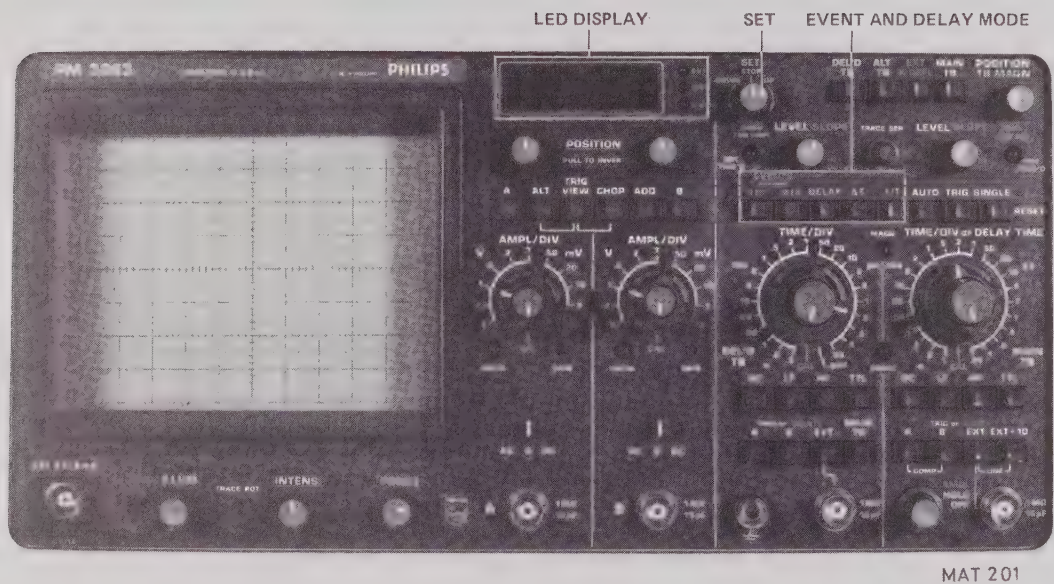


Abb. 3.5. Ereigniszählung und Verzögerung

- LED Anzeige EV leuchtet
DIV leuchtet:
S or Hz leuchtet:
Knopf SET
Anzahl der zu zählenden Ereignisse (Impulse) wird angezeigt.
Anzahl von Teilen des Elektronenstrahlröhrenbildes in Betriebsart DELAY und Betriebsart ΔT wird angezeigt wenn der MAIN TB Feineinsteller nicht auf CAL steht.
Wenn Knopf 1/T nicht gedrückt ist wird Zeit angezeigt.
Wenn Knopf 1/T gedrückt ist wird Frequenz angezeigt.
Zur Einstellung der Anzahl der zu zählenden Ereignisse in Betriebsart "Ereigniszählung".
Zum Einstellen der DELAY Zeit und der ΔT Intervallzeit in diesen Betriebsarten.
- Betriebsartschalter EVENTS und DELAY
EVENTS BEFORE DTB
Der Ereigniszähler wird zur Verzögerung der verzögerten Zeitbasis benutzt.
EVENTS BEFORE MTB
Der Ereigniszähler wird zur Verzögerung der Hauptzeitbasis benutzt.
DELAY
Die verzögerte Zeitbasis startet eine gewisse Zeit nach dem Starten der Hauptzeitbasis. Diese Zeit ist mit Knopf SET einstellbar, und ist von der LED-Anzeige ablesbar.
 ΔT
(Intervall)
Doppelte verzögerte Zeitbasis. Der Intervall zwischen den beiden verzögerten Zeitablenkungen ist mit Knopf SET einstellbar, und ist von der LED-Anzeige ablesbar.
Angewandt bei Messungen zwischen zwei Punkten eines komplexen Signals.
1/T
Wenn DELAY oder ΔT Zeit eine Periode des Signals umfasst wird der Frequenz des Signals in der LED Anzeige dargestellt.

3.5. EINIGE ALLGEMEINE INFORMATIONEN DIE ARBEITSWEISE DES PM3263 BETREFFEND

3.5.1. Eingänge A und B

Der Oszillograf besitzt zwei identische Kanäle, die entweder zusammen mit einem oder beiden Zeitablenkengeneratoren für YT-Messungen, oder aber zusammen mit dem externen Horizontalkanal für XY Messungen verwendet werden können.

YT-Messungen

Zur Darstellung eines Signals ist einer der beiden Vertikalkanäle mit Taste A oder Taste B der Darstellungsartenschalter zu wählen.

Wird Taste ALT oder CHOP gedrückt, können zwei verschiedene Signale gleichzeitig abgebildet werden. Der Y-Ablenkoeffizient und die Polarität können für jeden Kanal getrennt gewählt werden. Wird Taste ALT betätigt wird die Darstellung beim Rücklauf des Zeitablenksignals von einem Kanal auf den anderen umgeschaltet. Obwohl Stellung ALT für alle Ablenkzeiten verwendet werden kann, ergibt für lange Ablenkzeiten Stellung CHOP eine bessere Bildgüte, da das abwechselnde Darstellen der beiden Eingangssignale während dieser langen Ablenkzeiten deutlicher sichtbar ist.

In Stellung CHOP, wird die Darstellung mit einer Festfrequenz von einem Kanal auf den anderen umgeschaltet. In Stellung ADD des Darstellungsartenschalters werden die Signalspannungen der beiden vertikalen Kanäle addiert. Abhängig von der Stellung der Polaritätsschalter wird entweder die Summe oder die Differenz der Eingangssignale dargestellt. Die Einstellung ADD ermöglicht auch Differenzmessungen. Bei diesen Messungen wird die Gleichtaktunterdrückung der Stellung ADD ausgenutzt. Wenn die Polaritätsschalter beider Kanäle in entgegengesetzten Stellungen stehen, werden die Gleichtaktteile der Signale von Kanal A und B im Verhältnis zu den Gegentaktteilen nur sehr geringfügig verstärkt.

XY-Messungen

Wenn Drucktaste EXT X DEFL des Horizontalablenkungsschalters eingedrückt ist, ist der Zeitablenkengenerator ausgeschaltet, wenn Taste A des TRIG OR X DEFL-Schalters eingedrückt ist. Ein Signal das über Kanal A zugeführt wird kann nun zur Horizontalablenkung verwendet werden. Der Schalter AC/0/DC und der Stufenabschwächer von Kanal A bleiben wirksam.

Einsteller X DEFL/HOLD OFF ermöglicht stufenlose Einstellung der Ablenkungskoeffizienten, für horizontale Verschiebung des Bildes wird Einsteller X POSITION verwendet.

Für X-Ablenkung kann auch der vertikale Kanal B verwendet werden.

In diesem Fall Taste B des TRIG OR X DEFL-Schalters eindrücken.

Es ist ferner möglich eine interne Spannung der Netzfrequenz, oder ein Signal angelegt an die EXT Buchse (Vorderseite rechts unten), für die X-Ablenkung zu verwenden. Zu diesem Zweck die betreffende Drucktaste des TRIG OR X DEFL-Schalters eindrücken.

Bei diesen Betriebsarten kann die Bildbreite mit dem X DEFL/HOLD OFF Potentiometer eingestellt werden. Mit diesem Potentiometer in Stellung CAL, beträgt der Ablenkungskoeffizient für externe Signale 50 mV/Teil. Durch Eindrücken der Tasten DC oder LF des Triggerkopplungsschalters der Hauptzeitbasis kann das externe Signal entweder gleichspannungs- oder wechsellspannungsgekoppelt werden (untere Frequenzgrenze 7 Hz).

AC/0/DC - Schalter

Die zu beobachtenden Signale sind an die Buchse(s) A und/oder B zu legen und der AC/0/DC Schalter abhängig von der Zusammensetzung der Signale auf AC der DC zu stellen. Da der vertikale Verstärker gleichspannungsgekoppelt ist, ist die ganze Bandbreite des Gerätes verfügbar und die Gleichspannungskomponenten werden in Stellung DC des AC/0/DC-Schalters als Bildverschiebungen sichtbar.

Sind kleine Signale hohen Gleichspannungen überlagert kann dies störend sein. Jede Abschwächung des Signals verursacht auch eine Abschwächung der kleinen Wechsellspannungskomponenten. In diesem Falle ist der Eingangsschalter in AC Stellung zu bringen wodurch ein Sperrkondensator die Gleichspannungs- und Niederfrequenz-Signale unterdrückt. Dies hat Dachschräge zur Folge bei Darstellungen von Niederfrequenzsignalen. Stellung 0 unterbricht das Signal und erdet den Verstärkereingang um den 0 V Pegel schnell bestimmen zu können.

3.5.2. Zeitbasis

Die Zeitbasisschaltungen liefern eine Sägezahnspannung um eine lineäre Horizontalablenkung zu erlangen.

Die Horizontalablenkgeschwindigkeit ist kalibriert so dass ein genau zeitbezogenes Bild erhalten wird.

Um ein stabiles Bild zu bekommen muss die Zeitbasis-Sägezahnspannung jedesmal an der gleichen Stelle der Signalform gestartet werden (dies wird Triggerung genannt).

Hauptzeitbasis

Bei der Hauptzeitbasis unterscheidet man drei Betriebsarten:

- AUTO** : Der Zeitablenkgenerator ist freilaufend solange keine Triggerung vorhanden ist. Sobald ein Triggersignal anliegt wird ein stabiles Bild erlangt.
- TRIG** : Der Zeitablenkgenerator läuft nur wenn ein Triggersignal vorhanden ist. Wenn kein Triggersignal vorhanden ist bleibt der Bildschirm dunkel.
- SINGLE** : Der Zeitablenkgenerator läuft nur einmal nach Empfang eines Triggerimpulses. Diese Betriebsart wird meist dann angewandt, wenn einmalige Vorgänge photographiert werden sollen. Nach einer einmaligen Ablenkung (SINGLE Sweep) ist die Zeitbasis durch nochmaliges Eindringen der Taste SINGLE zum Empfang des nächsten Triggerimpulses bereit.

Variable "hold-off" Zeit

Die "hold-off" Zeit (Sperrzeit) ist die Zeit zwischen dem Ende einer Zeitablenkung und dem Moment bei welchem die Schaltung zur Triggerung am nächsten Triggerimpuls bereit ist. Bei komplexen Signalen (z.B. Doppelimpulssignale) kann normalerweise Doppeltriggerung vorkommen, was ein unstabiles Bild zur Folge hat. Mit Hilfe von Steller HOLD OFF kann die Sperrzeit, um Doppeltriggerung zu vermeiden, eingestellt werden. Mit HOLD OFF in Stellung CAL hat die Sperrzeit ihren niedrigsten Wert.

Verzögerte Zeitbasis

Der verzögerte Zeitablenkgenerator ist im Grunde der gleiche wie der Hauptzeitablenkgenerator.

Der verzögerte Zeitablenkgenerator ist jedoch nur während der Hauptzeitablenkung wirksam.

Die verzögerte Zeitbasis wird gewöhnlich zur näheren Betrachtung von Einzelheiten in komplexen Signalen.

Wenn Taste DEL'D TB gedrückt ist wird nur die verzögerte Zeitablenkung dargestellt.

Wenn die Taste MAIN TB der verzögerten Zeitbasis-Triggerquelle gedrückt ist, wird die verzögerte Zeitablenkung an einem bestimmten Zeitpunkt während der Hauptzeitablenkung starten.

Die verzögerte Zeitbasis startet dann ohne Triggerung; die Verzögerungszeit ist in der LED-Anzeige sichtbar.

Als Folge eines möglichen grossen Ablenkzeitverhältnisses zwischen verzögerter Zeitbasis und Hauptzeitbasis kann etwas Jitter entstehen wenn nur die verzögerte Zeitbasis dargestellt wird. Durch Triggerung der verzögerten Zeitbasis (mit A, B oder EXT) lässt sich das Jitter unterdrücken. Da die Zeit in der LED-Anzeige jetzt nicht mehr zuverlässig ist wird UNCAL 1 gezeigt.

Das Oszilloskop PM 3263 hat eine doppelt verzögerte Zeitbasis (ΔT Betrieb).

Dadurch erhält man zwei verzögerte Zeitablenkungen auf einer Hauptzeitablenkung.

Die verzögerte Zeitablenkung wird auf eine kurze Zeit eingestellt um eine Markenfunktion zu erlangen.

Die Verzögerungszeit und die ΔT Zeit können in der LED-Anzeige sichtbar gemacht werden.

Eine weitere Möglichkeit des PM 3263 ist Triggerung nach Ereigniszählung, sowohl für Hauptzeitbasis oder verzögerte Zeitbasis. Die Anzahl von Ereignissen (Impulsen) kann für jeden beliebigen Wert zwischen 0 und 99999 eingestellt werden.

Der Ereigniszähler zählt nur Triggerimpulse die in der Triggerschaltung der verzögerten Zeitbasis vorhanden sind.

Der Ereigniszähler beginnt zu zählen wenn der Hauptzeitbasis-Triggerimpuls anliegt.

Dehnung der Zeitablenkung MAGN

Die Dehnung der Zeitablenkung wird mit einem Zug-Druck-Schalter der an den Einsteller für horizontale POSITION gekoppelt ist, eingestellt. Wenn dieser Schalter in Stellung X10 gezogen ist wird ein 10 mal schnellerer Zeitmasstab des Hauptzeitablenkgenerators eingestellt. Folglich wird der Signalteil, welcher in der X1 Stellung (TB MAGN eingedrückt) über eine Breite von ein Teil (DIV) in der Schirmmitte dargestellt wird, in der X10 Stellung über die Gesamtbreite des Schirmes geschrieben.

Jeder Teil des Bildes kann mit dem horizontalen POSITION Einsteller zur genauen Beobachtung sichtbar gemacht werden.

In der X10 Stellung wird der Zeitkoeffizient durch Teilen des gegebenen Wertes TIME/DIV durch 10 ermittelt.

Wenn TB MAGN eingeschaltet ist verändert die LED-Anzeige nicht sondern bleibt im normalen Zustand (X1).

Gebrauch der alternierenden Zeitablenkung ALT TB

Das PM 3263 ist mit Darstellungsumschaltung ausgerüstet. Diese Vorrichtung erlaubt dem Gebraucher gleichzeitige Darstellung des Signals an den beiden von der Hauptzeitablenkung und von der verzögerten Zeitablenkung zur Verfügung gestellten Zeitmassstäben.

Genauere Beobachtung eines bestimmten Abschnitts der Hauptzeitbasis-Darstellung wird durch Erweiterung des betreffenden Zeitintervalls mit Hilfe der verzögerten Zeitbasis ermöglicht. Durch Wahl einer entsprechend schnelleren Ablenkung für TIME/DIV der verzögerten Zeitbasis wird die Erweiterung erzielt.

Der von der verzögerten Zeitbasis ausführlich zu beobachtende Teil des Signals bleibt als ein aufgehellter Bildausschnitt der Hauptzeitbasis. Dies erleichtert nicht nur die Lokalisierung des gewünschten Details, sondern dient auch als Sichtanzeige des zu betrachtenden Ausschnitts des Gesamtbildes. Man kann auf sofort das Detail mit dem Signal, welches sehr komplex sein kann, in Beziehung bringen, ohne dabei zwischen MAIN TB und DEL'D TB schalten zu müssen.

Mit TRACE SEP ist die Vertikalverschiebung zwischen den beiden Zeitbasen kontinuierlich einstellbar.

3.5.3. Triggerung

Wenn ein Signal dargestellt werden soll, muss, um ein stillstehendes Bild zu erhalten, die Horizontalablenkung stets an einem festen Punkt des Signals gestartet werden.

Der Zeitablenkgenerator wird folglich von in der Triggereinheit erzeugten schmalen Triggerimpulsen gestartet und durch ein Signal gesteuert das entweder den vertikalen Eingangssignalen, einer internen Netzfrequenzspannung oder einer externen Quelle entstammen kann.

In der Triggereinheit werden die Triggerimpulse durch Vergleich des Eingangssignals mit einer einstellbaren Gleichspannung (LEVEL) gewonnen.

Der Triggerpegel ist bei interner Triggerung (A oder B) auf die vertikale Ablenkrate und bei EXT Triggerung auf die Eingangsspannung bezogen.

Triggerkopplung

Mit Schalter DC/LF/HF/TTL kann man vier verschiedene Triggerkopplungsarten wählen. In den Stellungen HF und LF ist die Übertragungscharakteristik begrenzt.

In Stellung DC wird das Triggersignal unverändert durchgelassen.

In Stellung LF wird ein 0 Hz (7 Hz bei externer Triggerung) bis 30 kHz Bandpass eingesetzt. Diese Stellung dient zur Verminderung von Störungen durch Rauschen.

In Stellung HF wird ein 30 kHz Hochpass eingesetzt. Diese Stellung kann zum Herabsetzen von Störungen durch Brummen verwendet werden.

Stellung TTL ermöglicht automatische Triggerung auf TTL-Pegeln.

Das Triggerfenster hat nun einen festen Wert (Steller LEVEL ist nicht wirksam).

Triggerquelle

Das Triggersignal kann intern Kanal A oder B entnommen werden oder extern über Buchse EXT. Bei interner Triggerung wird das interne Triggersignal von stufenlosen Steller AMPL nicht beeinflusst.

Hauptzeitbasis

Die Hauptzeitbasis kann auch über eine 1:10 Spannungsabschwächerschaltung getriggert werden, wodurch höhere externe Triggerspannungen möglich sind.

Zusammengesetzte Triggerung (composite) wird durch Eindrücken der beiden Tasten A und B gewählt. Bei dieser Betriebsart wird die Triggerspannung Kanal A oder B entnommen, je nachdem welcher Kanal am Schirm erscheint. Zusammengesetzte Triggerung ist nicht anwendbar in der CHOP'D Mode, denn der Chopperspannung wird dann als Triggerspannung verarbeitet.

Netztriggerung (= Triggerung durch ein Signal von der Netzspannung) wird gewählt wenn die beiden Tasten EXT und EXT÷10 gedrückt sind.

3.5.4. Mikroprozessor

Die hauptsächlichen Aufgaben des Mikroprozessors sind:

- Prüfung der Stellung der verschiedenen Bedienungsorgane auf der Frontplatte
- Laden der LED-Anzeige
- Laden des Ereigniszählers
- Laden des Digital-Analog Umsetzers um die Vergleichsspannung der verzögerten Zeitbasis zu erhalten.
- Errechnen des $1/T$ Wertes.

3.6. GRUNDEINSTELLUNGEN

3.6.1. GAIN-Kalibrierung

- Drucktaste A des Darstellungsartenschalters betätigen.
- Drucktaste AUTO des Triggerartenschalters betätigen.
- Drucktaste MAIN TB des Horizontalablenkungsschalters betätigen.
- Bild mit Einsteller POSITION zentrieren.
- Mit LEVEL, INTENS und FOCUS ein scharfes und deutliches Bild einstellen.
- Schalter AC-0-DC in Stellung DC.
- Schalter AMPL in Stellung 0,5 V und stufenlosen Einsteller in Stellung CAL.
- Buchse CAL mit Eingangsbuchse A verbinden.
- Prüfen ob die Bildhöhe 6 Teile beträgt.
Nötigenfalls Einstellung GAIN unter dem Schalter AMP neu einstellen.

Bei Verwendung eines 1:10 Abschwächer Tastkopfs, den Schalter AMPLitude auf 50 mV/DIV. Den Rechtecksignal Frequenzgang des Tastkopfs prüfen.

Für Kanal B wiederholen.

3.6.2. Ausrichten der Leuchtpur (TRACE ROT)

- Drucktaste A des Darstellungsartenschalters betätigen.
- Drucktaste MAIN TB des Horizontalablenkungsschalters betätigen.
- Die Zeitbasislinie mit Einsteller POSITION zentrieren.
- Kontrollieren dass die Zeitbasislinie genau parallel zur horizontalen Rasterlinie liegt; falls erforderlich Steller TRACE ROT auf der Frontplatte, von neuem einstellen.

3.7.2. DELAY und ΔT Betrieb

Diese Betriebsart ist eine Erweiterung des DELAY-Betriebs. Durch Drücken des ΔT Knopfs erreicht man dass auf dem Schirm der Elektronenstrahlröhre zwei verzögerte Zeitablenkungen während der Hauptzeitablenkung erscheinen*.

Bemerkung: Bei der Anfangseinstellung des ΔT Betriebs fallen die beiden verzögerten Zeitbasismarken zusammen.



ΔT sind jede der totalen Hauptzeitbasis-Ablenkzeit gleich.

Wenn die Zeit in ΔT Betrieb eingestellt wird, ist es möglich dass die Summe: Verzögerungszeit und ΔT Zeit die Ablenkzeit der Hauptzeitbasis überschreitet.

Die ΔT Marke verschwindet jedoch nicht von Schirm der Elektronenstrahlröhre, sondern stoppt am Ende der Hauptzeitablenkung.

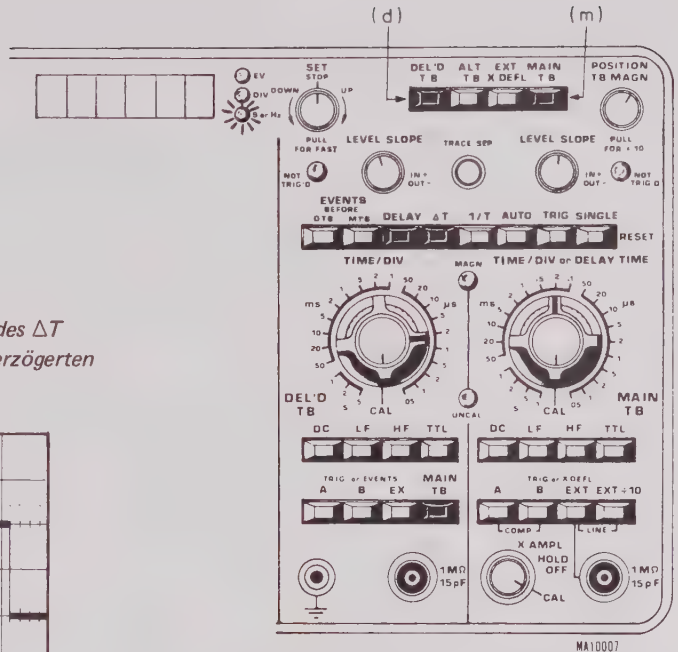
Die ΔT Zeit bleibt in einem internen Speicher, so dass wenn der Wert der Verzögerungszeit verringert ist die ΔT Marke in einem bestimmten Augenblick wieder verschiebt.

LED DIV

Wenn die MAIN TB Feineinstellung nicht auf CAL steht, dann kann die LED-Anzeige die ΔT Zeit nicht in Sekunden (oder msec oder μ sec) anzeigen, sondern wird sie in Schirmteilen angezeigt. In diesem Fall leuchtet Lampe DIV und die Lampe S oder Hz ist aus.

TB MAGN

Wenn TB MAGN eingeschaltet ist, verändert die LED-Anzeige nicht sondern bleibt in normalen Zustand (x1).



ΔT ist die Zeit die zwischen den Startpunkten der beiden verschiedenen verzögerten Zeitablenkungen am Elektronenstrahlröhrenschirm verstreicht.

Der ΔT Betrieb eignet sich besonders für Zeitmessungen in komplexen Signalen. Die beiden verzögerten Zeitablenkungen dienen als Marken.

Sowohl Verzögerungszeit wie ΔT sind mit Knopf SET einstellbar. Durch Einstellung der DEL'D TB Ablenkung (d) werden die beiden verzögerten Ablenkungen über den gesamten Elektronenstrahlröhrenschirm dargestellt. Das Zusammenfallen beider verzögerter Ablenkungen lässt sich mit Knopf SET einstellen, so dass die genaue ΔT in der LED-Anzeige erscheint.

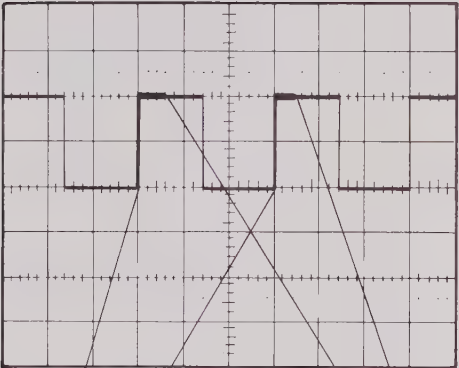
Es ist zu beachten dass zur Einstellung der Verzögerungszeit nur Knopf DELAY eingedrückt werden muss. Die ΔT kann eingestellt werden wenn Knopf ΔT eingedrückt ist.

Der Maximumwert von Verzögerungszeit und

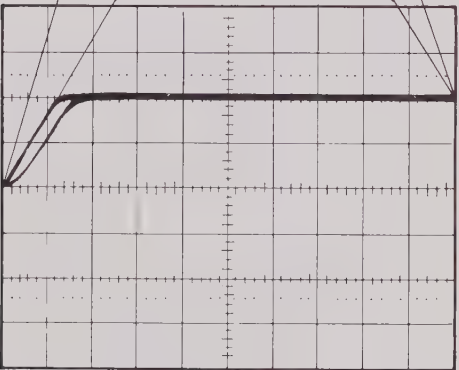
*) Tatsächlich wird die verzögerte Zeitablenkung DELAY auf eine Hauptzeitablenkung geschrieben und die verzögerte Zeitablenkung DELAY und ΔT auf die folgende Hauptzeitablenkung und so weiter.

3.7.3. 1/T Betrieb

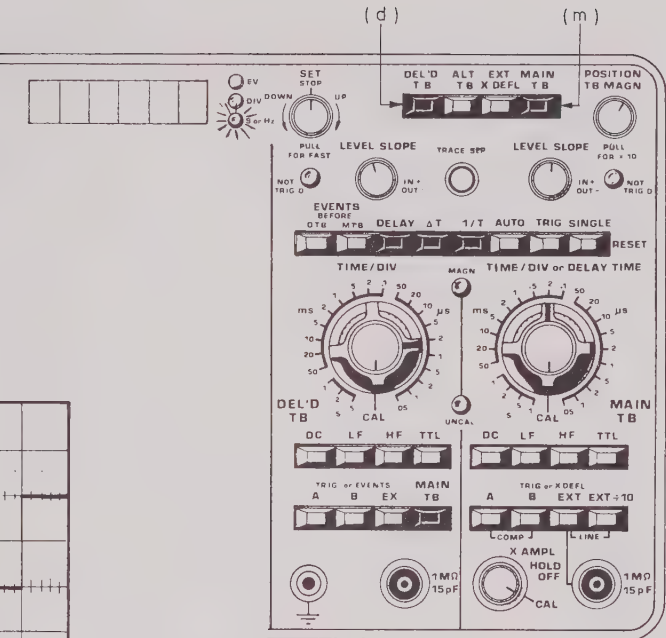
Diese Betriebsart ist eine Erweiterung des ΔT -Betriebs. Eindrücken der Taste 1/T erlaubt Frequenzmessungen.



Main TB deflection (m)



Del'd TB deflection (d)



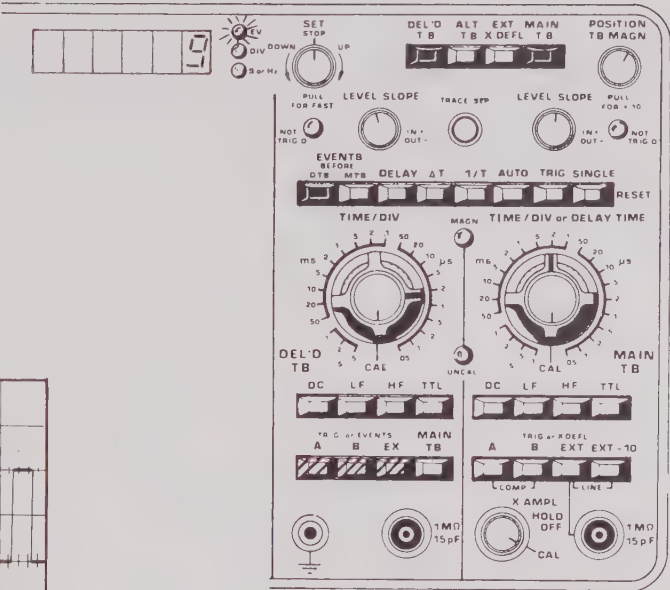
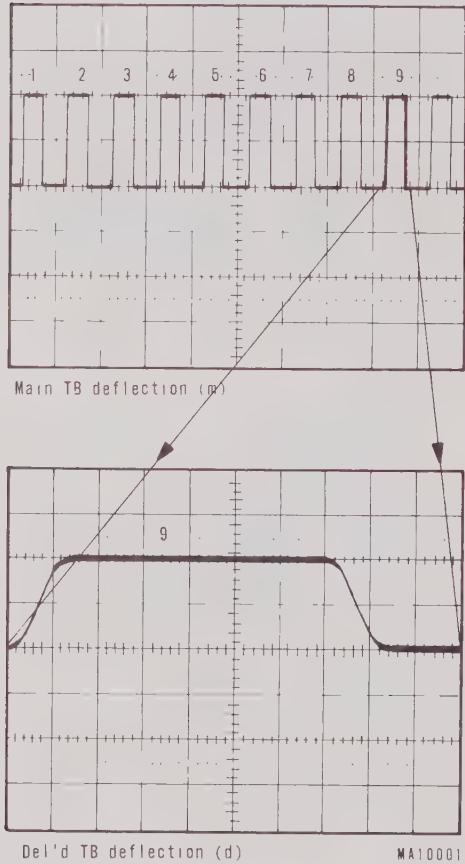
MA10000

Einstellen der beiden Marken am gleichen Punkt von zwei aufeinander folgende Zyklen eines Signals ermöglicht die direkte Ablesung der Frequenz dieses Signals von der LED-Anzeige. Zur genauen Einstellung der Marken die Horizontalablenkung DEL'D TB einstellen und kontrollieren dass die beiden Marken zusammenfallen.

MA10000

3.7.4. Ereignisse vor DTB

In dieser Betriebsart wird die verzögerte Zeitbasis nach Zählung einer voreingestellten Anzahl von Ereignissen (Impulsen) getriggert. Die verzögerte Zeitbasis muss von A, B oder EXT getriggert werden. Die Anzahl der zu zählenden Ereignisse ist in der LED-Anzeige ersichtlich und ist mit Knopf SET einstellbar. Maximal können bis zu 99999 Ereignisse gezählt werden.



Beachten, dass wenn Knopf MAIN TB der verzögerten Zeitbasis-Triggerwahlschalter gedrückt ist in der LED-Anzeige die Angabe "ERROR" (Fehler) erscheint (weil dann kein Triggersignal vorhanden ist).

Der Ereigniszähler beginnt im Moment des Starts der Hauptzeitablenkung zu zählen.

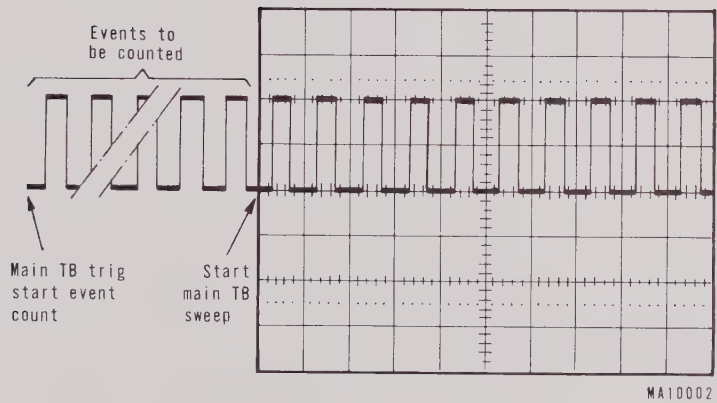
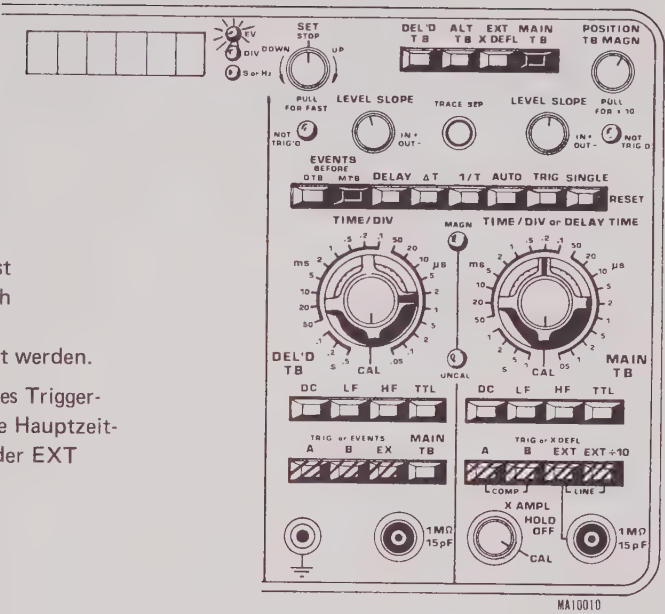
Wenn die Lampe NOT TRIG'D der verzögerten Zeitbasis leuchten bleibt, ist es möglich dass eine grössere Anzahl Ereignisse eingestellt ist als während einer Hauptzeitablenkung zur Verfügung stehen, oder der Triggerregler ist nicht richtig eingestellt.

3.7.5. Ereignisse vor MTB

In dieser Betriebsart wird die Hauptzeitbasis nach Zählung einer voreingestellten Anzahl von Ereignissen (Impulsen) welche der verzögerten Zeitbasis-Triggerschaltung (A, B oder EXT) zugeführt wurden, getriggert.

Die Anzahl der zu zählenden Ereignisse ist in der LED-Anzeige sichtbar und lässt sich mit Hilfe von Knopf SET einstellen. Maximal können 99999 Ereignisse gezählt werden.

Der Ereigniszähler beginnt bei Ankunft des Triggerimpulses der Hauptzeitbasis zu zählen; die Hauptzeitbasisschaltung muss ebenfalls von A, B oder EXT getriggert werden.



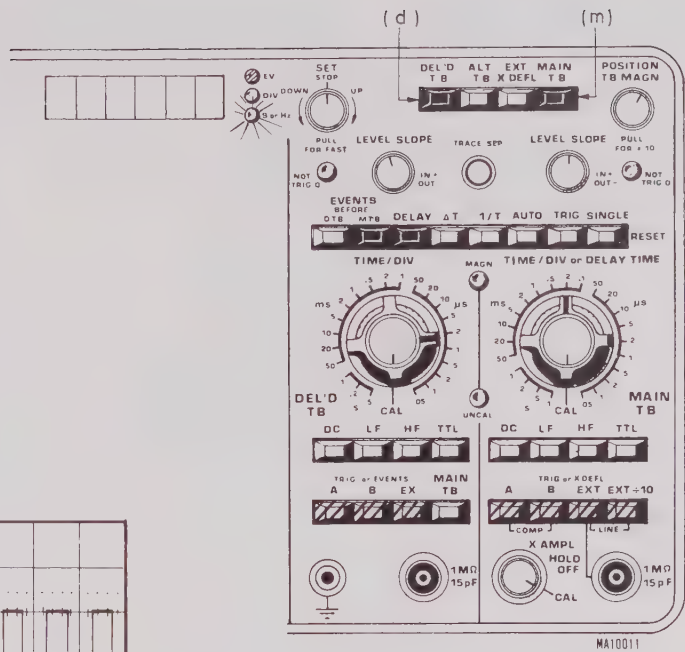
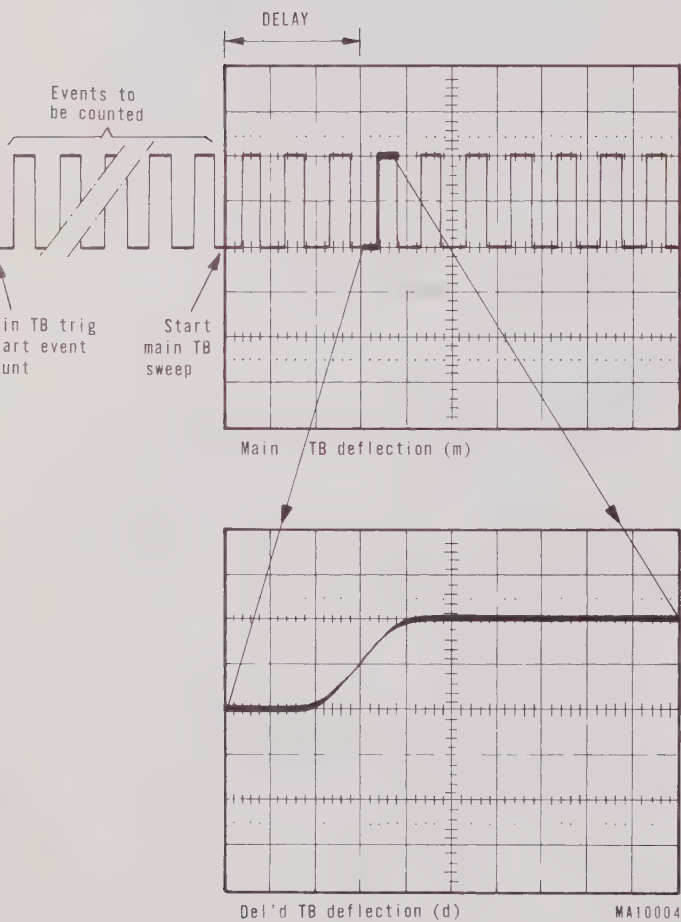
Zum besseren Verständnis sind die zu zählenden Ereignisse hier links neben dem Elektronenstrahlröhrenbild veranschaulicht.

Die Betriebsart EVENTS BEFORE MTB ist geeignet zur gemeinsamen Anwendung mit den Betriebsarten DELAY und ΔT.

3.7.6. Ereignisse vor MTB und DELAY

Dies ist eine Erweiterung der
hiervor beschriebenen Betriebsart.
Die Hauptzeitbasis triggert nach
Zählung einer voreingestellten Anzahl
von Ereignissen (Impulsen) die in der
Triggerschaltung der verzögerten
Zeitbasis (A, B oder EXT).

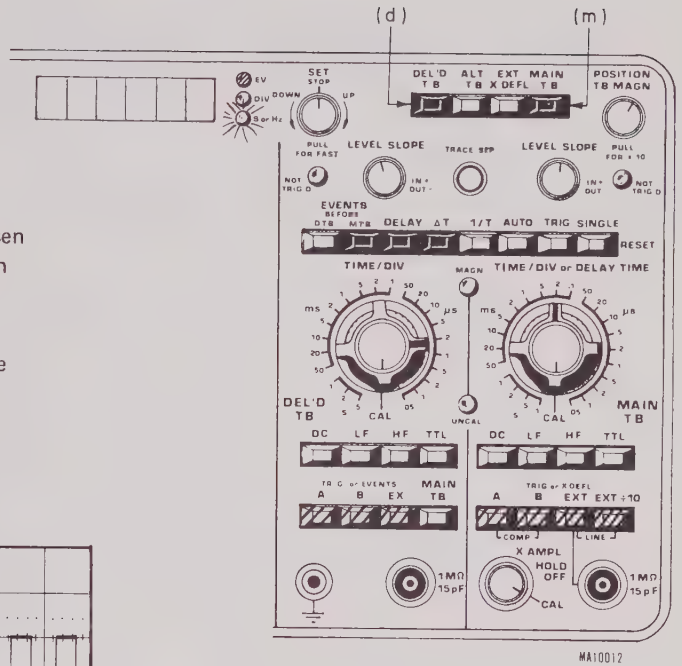
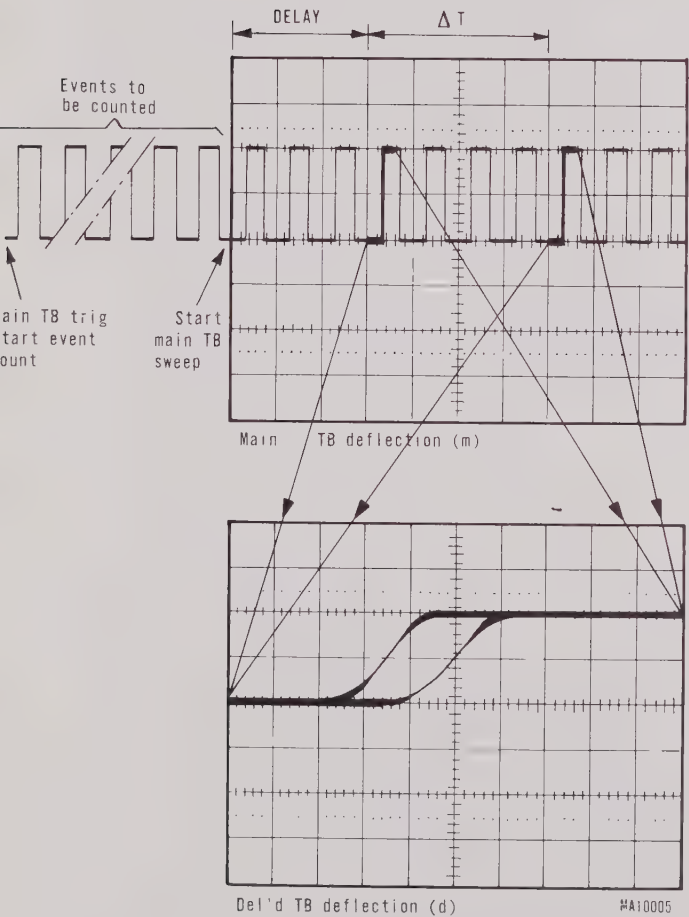
Erst nur EVENTS BEFORE MTB
eindrücken und die Anzahl der zu
zählenden Ereignisse wählen.



Danach auch DELAY drücken
und die Verzögerungszeit
einstellen.

3.7.7. Ereignisse vor MTB und DELAY und ΔT

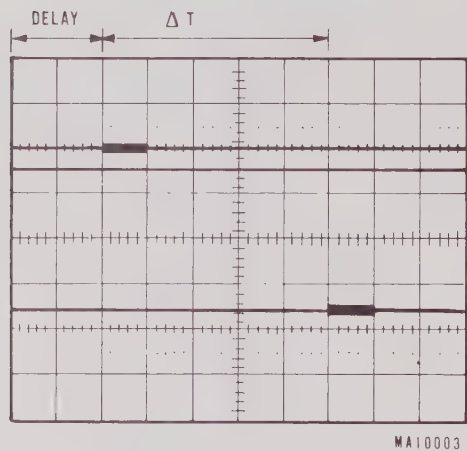
Dies ist eine weitere Erweiterung der Betriebsart EVENTS BEFORE MTB. Die beiden verzögerten Zeitablenkungen können als Marken benutzt werden, ΔT ist der Zeitintervall zwischen den Marken. Die Hauptzeitbasis triggert nach Zählung einer voreingestellten Anzahl von Ereignissen die in der Triggerschaltung der verzögerten Zeitbasis (A, B oder EXT) vorhanden sind. Erst nur EVENTS BEFORE MTB drücken und die Anzahl der zu zählenden Ereignisse wählen.



Danach auch DELAY eindrücken und die Verzögerungszeit (die Lage der ersten Marke) einstellen. ΔT ebenfalls drücken und die Intervallzeit (die Lage der zweiten Marke) einstellen. Zur genauen Einstellung der Marken die Horizontalablenkung DEL'D TB einstellen und kontrollieren ob beide Marken übereinstimmen.

3.7.8. Verzögerung und ΔT betrieb kombiniert mit alternierender Anzeige

Wenn diese Betriebsart eingestellt ist zeigt das A-Signalbild nur die erste verzögerte Zeitablenkung und das B-Signalbild zeigt nur die zweite verzögerte Zeitablenkung.



Diese Betriebsart ist nützlich für Zeitmessung zwischen zwei verschiedenen Teilen zweier Signale.
Beide Signale müssen zeitbezogen sein (z.B. vom gleichen Taktgeber synchronisiert).

Ein Signal an den A-Kanal Eingang legen und das andere an den B-Kanal Eingang.
Hauptzeitbasis Triggerquelle kann von A, B oder EXT kommen.
Beide Signalteile durch Einstellung der DELAY und der DELAY und ΔT Zeit wählen.
Die Zeit zwischen dem Beginnpunkt der beiden aufgehellten Signalbildteile erscheint in der LED-Anzeige.
Für genaue Einstellung die Horizontalablenkung DEL'D TB wählen.

3.7.9. LED-Anzeige mit Steller "SET"

Diese Anzeige ist 6-stellig und leuchtet wenn:

- 1° EVENTS BEFORE MTB gewählt ist
- oder
- 2° Knopf DTB TIME/DIV nicht in Stellung OFF steht.
- und
- EVENTS BEFORE DTB } gewählt ist
- oder DELAY }
- oder ΔT

Unabhängig von oben erwähnten Bedingungen leuchtet die Anzeige:

- während des Einschalttests im Augenblick des Einschaltens des Oszilloskops
- beim Selbsttest (siehe im Serviceteil dieser Anleitung).

Die LED-Anzeige gibt an:

- Eine Anzahl Ereignisse (Impulse) in Betriebsart EVENTS BEFORE DTB oder MTB; die EV Lampe leuchtet. Mit Steller SET ist jede Zahl zwischen 1 und 99999 wählbar.
- Eine Zeitdauer in Betriebsart DELAY oder ΔT . Diese Zeit wird in einer Mantisse mit einem Zehn-Exponenten angezeigt. Die maximale angezeigte Zeit in der LED-Anzeige ist gleich der eingestellten Ablenkzeit der Hauptzeitbasis.
- Eine Frequenz (in Betriebsart 1/T) in Mantisse mit einem Zehn-Exponenten.

Andere Anzeigemöglichkeiten:

– *TB OFF*

Zeigt an dass für Horizontalablenkung EXT X DEFL gewählt wurde.

– *ERROR*

Zeigt an dass in Betriebsart EVENTS die Triggerquelle MTB der DTB-Triggerung gewählt wurde. A, B oder EXT des DTB Triggerung drücken.

– *UNCAL*

In der Anzeige kann das Wort UNCAL zusammen mit Ziffer 1, 2 oder 3 erscheinen.

Die Anzeige UNCAL zeigt dem Benutzer des Geräts an, dass bei diese Einstellung keinen kalibrierte Messung möglich ist.

UNCAL 1 Bedeutet, dass in der Betriebsart DELAY oder ΔT zur DTB Triggerung A, B oder EXT als Quelle gewählt wurden.
MTB-Triggerquelle der DTB Triggerung eindrücken.

UNCAL 2 Gibt an, dass in Betriebsart 1/T der Abstand zwischen den Marken kleiner ist als 0,1 Teil; in diesem Falle ist der in der Anzeige dargestellte Wert nicht mehr genau.
Eine kürzere Einstellung der MTB Ablenkung wählen oder die Zeit mit Hilfe von Knopf SET verlängern.

UNCAL 3 Gibt an, dass in Betriebsart 1/T die Feineinstellung der MTB Ablenkung nicht auf CAL steht.

– *Lampe EV*

Leuchtet wenn in der Anzeige eine Anzahl zu zählender Ereignisse erscheint.

– *Lampe DIV*

Leuchtet wenn in Betriebsart DELAY oder ΔT der Schalter MAIN TB nicht in Stellung CAL ist.
Nun ist in der LED-Anzeige keine Zeit sichtbar sondern statt dessen eine Zahl von Bildschirmteilen.
Lampe S or Hz erlischt dann.

– *Lampe S or Hz*

Leuchtet in Betriebsart DELAY oder ΔT oder 1/T.

– *SET*

Dieser Knopf ermöglicht Einstellung der Verzögerungszeit(en) in Betriebsart DELAY TIME oder ΔT und der Anzahl der zu zählenden Ereignisse in den Betriebsarten EVENTS BEFORE DTB oder EVENTS BEFORE MTB.

Jede Betätigung dieses Knopfes beeinflusst unmittelbar die Daten in der LED-Anzeige.

In der Mittelstellung dieses Knopfes (STOP) bleiben die Daten der LED-Anzeige unverändert.

Rechtsdrehung des Knopfes erhöht und Linksdrehung verringert den Wert in der LED-Anzeige. Je mehr der Knopf von der Mitte weggedreht wird, desto höher ist die Veränderungsrate in der LED-Anzeige.

Durch drücken des Knopfes SET wird die Veränderungsrate um den Faktor 100 erhöht.

4. KURZES PRUFVERFAHREN

4.1. ALLGEMEINE INFORMATION

Die Funktionsprüfung soll der Überprüfung der Hauptfunktionen des Oszillographen mit einem Minimum von Prüfschritten und Arbeitsvorgängen dienen. Dabei wird vorausgesetzt, dass die die Funktionsprüfung ausführende Person mit dem Oszillographen und seinen charakteristischen Eigenschaften vertraut ist.

ACHTUNG: Vor dem Einschalten muss gewährleistet sein, dass der Oszillograph gemäss den Anweisungen in Kapitel 2 installiert wurde.

Wenn die Funktionsprüfung bereits wenige Minuten nach dem Einschalten begonnen wird, muss berücksichtigt werden, dass einzelne Funktionen wegen einer zu geringen Aufwärmzeit noch ausserhalb der Toleranzen liegen. Um sicherzustellen, dass dies nicht der Fall ist, sollte der vollständige Ablauf der angegebenen Aufwärmzeit abgewartet werden. Die Prüfung sollte bei einer Umgebungstemperatur zwischen 20 und 30°C erfolgen. Die zu überprüfenden Messwerte werden ohne Toleranzen angezeigt und entsprechen den Betriebsdaten eines durchschnittlichen Geräts. Hinsichtlich der Toleranzen wird auf das Kapitel 1.2. "Betriebsdaten" verwiesen. Die einzelnen Prüfungen erfolgen unter Verwendung des in das Gerät eingebauten Eichspannungsgenerators.

4.2. AUSGANGSSTELLUNGEN FÜR DIE BEDIENUNGSELEMENTE

Nach dem Einschalten des Geräts wird anhand der Leuchtdiodenanzeige überprüft, ob der Mikrocomputer die Überprüfung auf das Einschalten der Speisespannung ausführt. Dabei erscheint an jeder Stelle von links nach rechts für die Dauer von 0,5 Sekunden eine . Anschliessend leuchten für 0,5 Sekunden die Leuchtdioden für EV, DIV und S auf.

- Niederdrücken der Taste AUTO der Wähleinrichtung S8 für die Triggerart.
- Niederdrücken der Drucktaste ALT der Wähleinrichtung S1 für die Auswahl der Vertikal-Darstellung.
- Schalten der Kanalschalter AMPL/DIV für die Kanäle A und B — Schalter S9 und S11 — auf die Stellung 0,5 V/DIV bei Einstellung der zugehörigen Feineinstellungen R8/S10 und R9/S12 auf die Stellung CAL.
- Einstellen der Einsteller R3/R4 und R4/S5 für die Funktion POSITION der Kanäle A und B auf deren Mittelstellung und Niederdrücken der Einsteller.
- Einstellen der Kopplungseinsteller S17 und S18 der Kanäle A und B für die Signale AC/O/DC auf die Null-Stellung.
- Einstellen des Schalters S15 für die Funktion TIME/DIV der Hauptzeitbasis auf die Position 0,1 ms/DIV und Einstellung der Feineinstellung R11/S16 dazu auf die Position CAL.
- Einstellung des Einstellers S13 für die Funktion TIME/DIV der verzögerten Zeitbasis in die Stellung OFF und Einstellung der zugehörigen Feineinstellung R10/S14 auf die Position CAL.
- Drücken der Drucktaste MAIN TB der Wähleinrichtung S2 für die Horizontal-Darstellung.
- Einstellung des Einstellers R2 für die Horizontal-Darstellung POSITION auf die Mittelstellung und Drücken des Einstellers.
- Drücken der DC-Drucktaste der Triggerkopplungsschalter S19 und S20 für die Funktionen MAIN TB und DEL'D TB.
- Die nichterwähnten Drucktasten müssen freigegeben werden.

4.3. ELEKTRONENSTRAHLROHRE – ANZEIGETEIL (C.R.T. Display Section)

- Einstellen von INTENSität und FOCUSierung mit den Einstellern R16 und R17 für eine einwandfreie Darstellung. Beim Ausführen von Prüfungen kann es erforderlich sein, die Einsteller nachzustellen.
- Zentrieren der Zeitbasislinien für die Kanäle A und B unter Verwendung der POSITION-Potentiometer R3, R4 und R2.
- Prüfen, ob Zeitbasislinien exakt parallel zur den horizontalen Gitterlinien verlaufen. Falls dies nicht der Fall ist, den Einsteller R15 für die Spurdrehung (TRACE ROTATION) betätigen. Dieser Einsteller ist an der Frontplatte vorgesehen und mit einem Schraubenzieher zu betätigen.

4.4. VERTIKALE KANALE

- Die Prüfung ist für die Kanäle A und B identisch. Die Knöpfe, Steckanschlüsse und Einstellelemente sind für den Kanal B hinter denjenigen für den Kanal A in Klammern angegeben.
- Einstellen des Schalters TIME/DIV für die Hauptzeitbasis auf die Position 50ms/DIV und Prüfung, ob Kanäle A und B alternierend angezeigt werden.
- Niederdrücken der Drucktaste CHOP der Wähleinrichtung für die vertikale Darstellungsart und Überprüfung, ob die Anzeige so aussieht als ob die Kanäle A und B gleichzeitig dargestellt würden.
- Einstellen des Schalters TIME/DIV für die Hauptzeitbasis auf die Position 0,1ms/DIV.
- Niederdrücken der Drucktaste A (B) der Wähleinrichtung für die Art der Vertikal-Darstellung: jetzt ist nur noch die Zeitbasislinie für Kanal A (B) sichtbar.
- Niederdrücken der Drucktaste A (B) der Wähleinrichtung S22 der Hauptzeitbasis-Triggerquelle.
- Anlegen der Ausgangsspannung vom CAL-Anschluss X1/X2 an Eingangsbuchse X3 (X4) für Kanal A (B).
- Einstellen des Kanal-Kopplungsschalters für Kanal A (B) auf die Stellung DC: nunmehr wird das Ausgangssignal vom CAL-Anschluss auf dem Bildschirm sichtbar.
- Der Einsteller LEVEL für die Hauptzeitbasis ist so einzustellen, dass die Signalform stabil dargestellt wird. Die Vertikal-Ablenkung muss 6 Teile betragen. Falls dies nicht der Fall ist, muss eine Nachstellung am Einstellpunkt R12 (R13) an der Frontplatte mit dem Schraubenzieher erfolgen.
- Auch der Einsteller S7 für die Trägersignalsteigung (SLOPE) die in den Einsteller R7 für den Pegel (LEVEL) integriert ist, ist zu überprüfen. Wenn der Einsteller R7/S7 gezogen wird, beginnt die Spur bei negativer Steigung des Signals, und wenn dieser Einsteller gedrückt ist, beginnt die Spur mit einer positiven Steigung des Signals.
- Das Signal, welches nunmehr angezeigt wird, ist eine Rechteck-Impulsfolge mit einem unteren Pegel von 0V und einem oberen Pegel von 3V. Das Signal enthält eine Gleichstrom-Komponente von 1,5V. Wenn der Kopplungsschalter AC/O/DC die Stellung AC einnimmt, wird die Gleichstromkomponente blockiert und das Signal wird nunmehr symmetrisch zur 0-V-Linie dargestellt. Jetzt ist die AC-Position zu überprüfen.
- Überprüfen, ob Signal von Kanal A (B) auf dem Bildschirm invertiert ist, wenn die Funktion PULL TO INVERT (zum Invertieren ziehen) durch Ziehen der Positions-Einsteller S4/R3 (S5/R4) für den Kanal A (B) eingeschaltet ist.
- Anschliessend wieder Drücken des Positionseinstellers für A (B).
- Drücken der Drucktaste EXT X DEFL der Wähleinrichtung S2 für die Art der Horizontal-Ablenkung.

- Drücken der Drucktaste A (B) der Wähleinrichtung S21 für die Hauptzeitbasis-Triggerquelle.
- Anlegen der Ausgangsspannung am CAL-Anschluss an den Eingangsanschluss für Kanal A (B).
- Niederdrücken der Drucktaste B (A) der Wähleinrichtung S1 für die Art der Vertikal-Ablenkung.
- Überprüfen, ob zwei Punkte dargestellt werden, die in horizontaler Richtung einen Abstand von 6 Teilstrichen (Gitterteilung) aufweisen.
- Drücken der Drucktaste TRIG VIEW der Wähleinrichtung für die Art der Vertikal-Ablenkung.
- Drücken der Drucktaste A (B) der Wähleinrichtung für die Hauptzeitbasis-Triggerquelle.
- Anlegen der Ausgangsspannung vom CAL-Anschluss an den Eingangsanschluss für Kanal A (B).
- Drücken der Drucktaste MAIN TB der Wähleinrichtung S2 für die Art der Horizontal-Ablenkung.
- Prüfen, ob ein Rechteck-Signal von 6 Teile auf dem Bildschirm dargestellt wird. Dieses Signal wird in vertikaler Richtung verschoben, wenn der Einsteller LEVEL für die Hauptzeitbasis betätigt wird.

4.5. Zeitbasen und Triggern

- Drücken der Drucktaste A (B) der Wähleinrichtung S1 für die Art der Vertikal-Ablenkung.
- Anlegen des Ausgangssignals vom CAL-Anschluss an den Eingangsanschluss für Kanal A (B).
- Drücken der Drucktaste A (B) der Wähleinrichtung S22 für die Hauptzeitbasis-Triggerquelle.
- Einstellen des Schalters TIME/DIV der Hauptzeitbasis auf die Position 0,1 ms/DIV.
- Drücken der Drucktaste MAIN TB der Wähleinrichtung S2 für die Art der Horizontal-Ablenkung.
- Einstellen des Einstellers R7 LEVEL der Hauptzeitbasis für eine getriggerte Darstellung.
- Ziehen des Knopfes R2/S3 TB MAGN der in den Horizontal-Einsteller POSITION integriert ist und überprüfen, ob Horizontal-Ablenkung um den Faktor 10 vergrößert ist.
- Drücken des Einstellers TB MAGN.
- Drücken der Drucktaste SINGLE des Einstellers S8 für die Art der Triggierung. Überprüfen, ob Hauptzeitbasis nach dem Freigeben dieser Drucktaste nur noch einmal läuft.
- Niederdrücken der Drucktaste AUTO der Wähleinrichtung für die Art der Triggierung.
- Einstellen des Einstellers S13 TIME/DIV für die verzögerte Zeitbasis auf die Position 20 μ s/DIV und Einstellen des zugehörigen Feineinstellers R10/S14 auf die Position CAL.
- Drücken der Drucktaste MAIN TB der Wähleinrichtung S21 für die Triggerquelle für die verzögerte Zeitbasis.
- Drücken der Drucktaste (S26) DELAY.
- Verstellen des Einstellers (R1/S24) SET von der Position STOP in die Position UP (aufwärts zählen). Prüfen, ob der verstärkte Teil des Durchlaufs der verzögerten Zeitbasis längs der Darstellung der Hauptzeitbasis nach rechts verschoben wird. Dabei muss die angezeigte Zahl zunehmen.
- Einstellen des Einstellers SET auf die Stellung abwärts zählen (DOWN counting). Prüfen, ob der verstärkte Teil des Durchlaufs der verzögerten Zeitbasis längs der Darstellung der Hauptzeitbasis nach links verschoben wird. Dabei muss die von der Anzeige angezeigte Zahl abnehmen.

- Es ist für eine Anzahl von Punkten des dargestellten Hauptzeitbasissignals zu überprüfen, ob die Verzögerung auf dem Bildschirm im Vergleich zu der von der Leuchtdiodenanzeige LED DISPLAY angezeigten Verzögerungszeit korrekt ist.
- Prüfen, ob in der Stellung UNCAL des Feineinstellers TIME/DIV für die Hauptzeitbasis die Anzeige die Verzögerung in Teilstrichen (DIV) statt in Sekunden anzeigt.
- Erneutes Einstellen des Einstellers TIME/DIV für die Hauptzeitbasis auf die Position CAL.
- Drücken der Drucktaste DEL'D TB des Einstellers S2 für die Art der Horizontal-Ablenkung. Prüfen, ob der verstärkte Teil nunmehr die gesamte horizontale Schirmbreite überdeckt.
- Drücken der Drucktaste ALT TB des Einstellers für die Art der Horizontal-Ablenkung. Nunmehr müssen sowohl das Hauptzeitbasis-Signal als auch der über die gesamte Schirmbreite dargestellte verstärkte Teil dargestellt werden. Die Vertikal-Verschiebung zwischen den beiden dargestellten Signalen muss dabei mit Hilfe des Einstellers R6 (TRACE SEParation) einstellbar sein.
- Drücken der Drucktaste MAIN TB des Einstellers S2 für die Art der Horizontal-Ablenkung.
- Einstellen der Verzögerung durch den Einsteller SET derart, dass der Beginn des verstärkten Signalteils mit der ersten negativen Steigung auf dem Bildschirm zusammenfällt.
- Drücken der Drucktaste ΔT (S27) und Positionieren eines zweiten verstärkten Signalteils mit Hilfe des Einstellers SET, derart, dass der zweite Signalteil mit der zweiten negativen Steigung auf dem Bildschirm zusammenfällt.
- Die Anzeige muss nunmehr die Zeitdifferenz ΔT zwischen den Anfängen der beiden verstärkten Signale anzeigen. Der angezeigte Wert ΔT muss dabei ungefähr 0,5ms betragen.
- Niederdrücken der Drucktaste 1/T (S28) und prüfen, ob die Anzeige nunmehr die Frequenz der Rechteck-Impulsfolge auf dem Bildschirm anzeigt. Diese Frequenz muss etwa 2kHz betragen.
- Freigabe der Drucktasten DELAY, ΔT und 1/T.
- Drücken der Drucktaste A(B) des Einstellers S21 für die verzögerte Zeitbasis-Triggerquelle.
- Einstellen des Hauptzeitbasis-Schalters TIME/DIV auf die Stellung 0,2ms/DIV.
- Drücken der Drucktaste S25 (EVENTS BEFORE DTB).
- Einstellen der Anzahl von Ereignissen in der Anzeige auf 4 (3, 2, 1).
- Einstellen des Einstellers R5/R6 (LEVEL/SLOPE) für die verzögerte Zeitbasis für einen verstärkten Signalteil der beim 4. (3., 2., 1.) positiven Anstieg des Signals auf dem Bildschirm beginnt.
- Prüfen, ob das verstärkte Signal dann, wenn der Einsteller R5/S6 (LEVEL/SLOPE) für die verzögerte Zeitbasis gezogen ist, bei der 4. (3., 2., 1.) negativen Steigung des Signals auf dem Bildschirm beginnt.
- Erneutes Drücken des Einstellers R5/S6 (LEVEL/SLOPE) für die verzögerte Zeitbasis.
- Einstellen des Einstellers TIME/DIV für die verzögerte Zeitbasis auf die Stellung OFF (aus).
- Drücken der Drucktaste S25 (EVENTS BEFORE MTB).
- Einstellen der Anzahl von Ereignissen (EV), die von der Anzeige angezeigt werden, auf 4.
- Prüfen, ob es möglich ist, den Einsteller R5/S6 (LEVEL/SLOPE) für die verzögerte Zeitbasis für eine getriggerte Darstellung einzustellen. Für diese Prüfung ist es erforderlich, dass auch der Einsteller R7/S7 (LEVEL/SLOPE) für die Hauptzeitbasis die getriggerte Stellung einnimmt. Die Anzeige NOT TRIG'D für die Zeitbasis muss also auf "aus" stehen.

5. VORBEUGENDE WARTUNG

5.1. ALLGEMEINES

Das Gerät erfordert im allgemeinen keine Wartung, das es keine dem Verschleiss ausgesetzte Bauteile enthält. Um jedoch verlässlichen und fehlerlosen Betrieb zu gewährleisten ist das Gerät vor Feuchtigkeit, Hitze, Korrosion begünstigenden Einflüssen und übermässigem Staub zu schützen.

5.2. REINIGEN DER NEXTEL LACK OBERFLÄCHE

WARNUNG: Der Nextel-Lack ist äthanolbeständig, jedoch nicht gegen Alkohol oder Methylalkohol (Brennspiritus) welcher die Oberfläche angreift (durch eine der denaturierenden Substanzen).

Das glänzende Aussehen der Nextel Lackierung des Gehäuses kann sich im Laufe der Zeit, als Folge von Verschmutzung, verschlechtern. Säubern mit einem in Wasser, Äthanol oder einem der üblichen Haushaltswaschmittel getränktem Tuch kann nicht immer den Glanz wiederherstellen und lässt Schmutzreste in Löchern und Poren zurück.

Die 3M Company hat einen neuartigen Putzlappen entwickelt ("White Cleansing Pad", Katalognummer 8440) der getränkt in Wasser, Äthanol oder in ein gewöhnliches Haushaltswaschmittel auch in Löcher und Poren eindringt.

Diese Methode ähnelt der von Scheuerlappen jedoch ohne deren kratzende Wirkung. Scheuernde Lappen dürfen nicht verwendet werden, da sie die Oberfläche zerkratzen.

5.3. NEUKALIBRIERUNG

Erfahrungsgemäss ist zu erwarten dass das Oszilloskop innerhalb von 1000 Betriebsstunden oder 6 Monaten bei fallweisem Betrieb seiner Spezifikationen arbeitet.

Ausserdem kann Ersetzen von Bauteilen eine Neukalibrierung der betreffenden Schaltung erforderlich machen. Das Prüf und Einstell Verfahren kann auch bei der Ermittlung gewisser Fehler im Gerät behilflich sein. In manchen Fällen werden geringfügige Fehler durch Neukalibrierung ermittelt und behoben. Vollständige Prüf- und Einstellanleitungen sind Abschnitt "Prüfung & Einstellung" zu entnehmen.

Notice d'emploi

1. GENERALITES

1.1. INTRODUCTION

Le PM 3263 est un oscilloscope portable à deux voies, à haute sensibilité et à large bande, pourvu de possibilités de réglage du temps grâce au microprocesseur incorporé.

Ces possibilités comprennent:

- Double base de temps retardée
- Déclenchement du compteur d'événements pour bases de temps retardée et principale
- Mesures de fréquence

Les résultats des mesures de fréquence et de temps et le nombre sélectionné d'événements à compter sont visualisés sur un affichage LED à 6 chiffres. De plus, l'affichage LED indique ERROR et UNCAL en fonction de l'erreur de manipulation.

Autres possibilités sont: la visualisation du déclenchement, l'affichage de base de temps alternée et le déclenchement TTL automatique.

La base de temps alternée permet l'affichage simultané d'un signal sur deux échelles de base de temps différentes (BTP et BTR).

L'oscilloscope est pourvu de plusieurs circuits intégrés garantissant le fonctionnement stable, ce qui réduit considérablement le nombre de points de réglage.

La tension d'alimentation est réglable sur deux gammes, de 90 V à 140 V et de 180 V à 265 V à l'aide d'un commutateur.

Toutes ces propriétés font du présent oscilloscope un instrument particulièrement utile dans une gamme étendue d'applications.



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Fig. 1.0. Oscilloscope PM3263

1.2. CARACTÉRISTIQUES TECHNIQUES

Cet instrument a été conçu et testé conformément à la norme C.E.I. 348 pour des appareils de classe I. A la livraison, il répond aux règles de sécurité. La présente notice comporte des informations et les avertissements nécessaires à l'utilisateur afin d'assurer le fonctionnement de l'instrument dans les conditions de sécurité requises et de le maintenir dans un état conforme à la norme.

- Toutes les spécifications sont valables après un temps d'échauffement de 30 minutes (température de référence 23°C) et sans modifier la position de l'appareil.
- Seules les valeurs accompagnées d'une tolérance ou d'une limite sont garanties; les caractéristiques sans tolérance sont données à titre indicatif.
- Les précisions (absolues ou en %) se rapportent à la valeur de référence indiquée.

Désignation	Spécification	Information supplémentaire
1.2.1. Tube à rayons cathodiques		
– Type	PHILIPS D14-302 GH/95	Tube à face rectangulaire, type domed mesh, post-accélérateur, couche phosphore doublée de métal.
Aire de mesure	80 mm x 100 mm	
– Type d'écran	Phosphore P31 (GH)	En option, couche phosphore P7 (GM) ou P11 (BE).
Vitesse d'écriture photo-graphique	> 1500 cm/μs	2000 cm/μs typique. Mesuré avec un appareil photographique Steinheil Oscillophot M5 Ouverture: 1:1,2 Rapport objet image: 1:0,5 Film: Polaroid 410 (10.000 ASA) Pas de prévoilage. Phosphore du type P31 (GH).
Tension d'accélération totale	17 kV	
Graticule	Interne	Illumination continuellement variable.
Gravures	Divisions centimétriques avec subdivisions de 2 mm sur les axes centraux. Les lignes interrompues en 1,5 et 6,5 div. du sommet d'affichage permettent de contrôler le temps de montée.	
– Rotation de trace	Réglage tournevis au panneau avant.	(Trace Rot.)
1.2.2. Axe vertical ou Y		
– Bande passante (gamme 2 mV exceptée)		
Gamme de fréquence	continu à 100 MHz 10 Hz ... 100 MHz	–3 dB largeur de bande en couplage continu. –3 dB largeur de bande en couplage alternatif. La gamme de fréquence inclut une sonde 10:1 à 20-30 °C.
Temps de montée	3,5 ns (voir fig. 1.2B)	
Dépassement	± 3 % crête-à-crête	Sur 6 divisions, +5 – +40 °C
(Pour spécifications 2 mV/DIV, se référer à la fin du présent chapitre)		

Désignation	Spécification	Information supplémentaire
— Coefficients de déviation	2 mV/DIV ... 5 V/DIV	En 11 positions étalonnées (progression 1-2-5) avec commande continue non-calibrée 1:≥ 2,5 par potentiomètre Indication de non-calibrage par lampe.
Erreur limite	± 3 %	
— Tension d'entrée maximale admise	± 400 V	Tension continu et tension alternative crête. Déviant à des fréquences supérieures à 500 kHz. Voir Fig. 1.3.
Déviati on maximale sans distorsion	24 divisions	Jusqu'à 35 MHz
Gamme de décalage	16 divisions	8 divisions au-dessus et au-dessous de la ligne horizontale centrale du graticule.
— Impédance d'entrée	1 MOhm ± 2 %//± 15 pF	Entrées A et B également réglées.
Constante de temps RC d'entrée	22 ms	Commutateur de couplage en position AC.
Instabilité de trace	0,1 div./heure	Gamme de température +20 - +40 °C.
Saut de trace	0,2 div.	Lorsque l'on commute l'atténuateur entre deux positions.
Saut de trace	0,5 div.	Lorsqu'on commute NORM/INVERT.
Dérive de trace	0,2 div.	Lorsqu'on tourne l'atténuateur continu. 0,4 div. en gamme 5 mV.
Dérive de trace	1 div.	En poussant le bouton ADDED 0,4 div. en gamme 5 mV. Croissante lorsqu'on tourne l'atténuateur continu.
Dérive de température à long terme	20 μV/°C	Valeur typique. Mesuré à 2 mV à 4 div.
— Retard visible du signal	environ 15 ns	
— Modes d'affichage	Voie + ou — A seulement Voie + ou — B seulement Affichage déclenchement seulement Voies ± A et ± B découpées Voies ± A et ± B alternées Voies ± A et ± B additionnées Affichage déclenchement ± A et ± B découpées ou alternées (affichage 3 voies).	Si l'affichage 3 voies est sélectionné avec l'affichage base de temps alternée l'ensemble est automatiquement affiché en mode de base de temps intensifiée. Si référer à Fig. 1.6.
— Fréquence de commutation	1 MHz	Temps d'affichage par voie: env. 350 ns.
— Diaphonie entre voies	1:500	Jusqu'à 50 MHz.
— Facteur de réjection en mode commun	Supérieur à 100 jusqu'à 2 MHz 20 à 50 MHz	En mode +A et —B additionnées signal max. en mode commun: 8 div.
— Affichage déclenchement		
Affichage	Signal de déclenchement externe ou interne	

Désignation	Spécification	Information supplémentaire
Réponse de fréquence	≥ 80 MHz	
Coefficient de déviation	Comme verticale	
Externe	100 mV/div. ± 3 %	
Externe ÷ 10	1 V/div. ± 5 %	
Interne	Vertical ± 10 %	
Point du déclenchement	Centre d'écran ± 0,3 div.	Couplage continu.
Aberrations	± 10 % crête-à-crête	
Retard de temps entre entrée verticale et entrée externe	3 ns ± 1 ns	
— Spécification pour réglage 2 mV/div.		
Coefficient de déviation	2 mV/div.	
Erreur limite	± 5 %	
Réponse		
Gamme de fréquence	continu 0 ... 35 MHz alternatif 10 Hz ... 35 Mhz	—3 dB largeur de bande supérieure —3 dB
Temps de montée	10 ns	
Aberration d'impulsion	± 5 % crête-à-crête	
Facteur de réjection en mode commun	Meilleure que 100 jusqu'à 2 MHz	
Instabilité de trace	0,25 div/heure	Gamme de température +20 - +40 °C.
Saut de trace	1 div.	Lorsque l'on commute entre 2 mV/DIV et 5 mV/DIV.
Saut de trace	2 div.	Lorsqu'on actionne le commutateur NORM/INVERT
Dérive de trace	1 div.	Lorsqu'on tourne l'atténuateur continu
Dérive de trace	1 div.	En poussant le bouton ADDED.

1.2.3. Axe horizontal ou X

— Modes de représentation	— Base de temps principale — Base de temps principale intensifiée par base de temps retardée — Base de temps retardée — Base de temps intensifiée et base de temps retardée affichées alternativement. — Mode X-Y et X-Y/Y	Séparation de trace de 4 divisions possible. Déviation X par: — le signal voie A — le signal voie B — le signal appliqué au connecteur EXT de la base de temps principale — la fréquence secteur
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Pour base de temps retardée double, se référer à 1.2.6.

— Dérive horizontale en position x1	0,2 div./heure	La dérive horizontale avec agrandisseur en position x1 ne peut pas excéder 0,1 div/heure dans la gamme de température +20 - +40 °C. La même stabilité est requise au démarrage du balayage dont la vitesse est variée, sauf pour les gammes de balayage supérieure (50-100 ns/div.).
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Désignation	Spécification	Information supplémentaire
— Commande de la position horizontal	$\pm 5,2$ div. à partir du centre de l'écran	La commande de décadrage horizontal combine le réglage gros et le réglage fin.

1.2.4. Base de temps principale

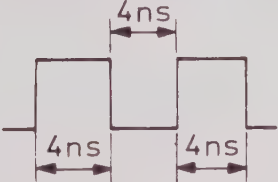
— Fonctionnements	Automatique Déclenché Balayage unique	En automatique, la base de temps est en fonctionnement libre en l'absence de signaux de déclenchement après moins de 0,1 s.
— Vitesses de balayage	1 s/div ... 50 ns/div	En 23 positions étalonnées (progression 1-2-5). Commande continue non-étalonnée 1:≥ 2,5 entre les échelons par potentiomètre. Une lampe indiquant le non-calibrage des deux bases de temps.
— Précision de mesure	$\pm 2\%$ $\pm 3\%$	Entre +20 °C et +30 °C Entre + 5 °C et +40 °C Différence de précision de balayage pour toutes 2 divisions est de $\pm 5\%$ à l'exclusion des premières et dernières divisions sur les positions 5 ns et 10 ns.
— Temps de blocage variable (hold-off)	Le temps de blocage du balayage peut être augmenté par un facteur 10.	Le temps de blocage est minimal en position extrême droite du bouton (CAL). Ce bouton est combiné avec la commande X AMPL.
— Agrandissement	10x	Commuté, étalonné. L'affichage coïncidant à la ligne de graticule horizontale centrale ne peut pas dévier de plus d'une division lors du réglage de l'agrandisseur horizontal sur x10.
Erreur de coefficient	$\pm 1\%$ supplémentaire	Premières et dernières 50 ns de 5 ns/div., 10 ns/div. et 20 ns/div agrandis $\pm 5\%$.
Coefficient de temps efficace maximal	5 ns/div.	

1.2.5. Base de temps retardée

— Fonctionnement	Normal Double	Démarré par MAIN TB ou déclenche (TRIG) Démarré par MAIN TB
— Vitesses de balayage	0,5 s/DIV ... 50 ns/DIV	En 22 positions étalonnées (progression 1-2-5). Commande continue non-étalonnée 1:≥ 2,5 entre les échelons par potentiomètre. Une lampe indiquant le non-calibrage des deux bases de temps.

Désignation	Spécification	Information supplémentaire
Précision de mesure	$\pm 2 \%$ $\pm 3 \%$	Entre $+20\text{ }^{\circ}\text{C}$ et $+30\text{ }^{\circ}\text{C}$ Entre $+5\text{ }^{\circ}\text{C}$ et $+40\text{ }^{\circ}\text{C}$ Cette précision de balayage, mesurée toutes les deux divisions sur 10 DIV est de 5 %, à l'exclusion des premières et dernières divisions sur les positions 5 ns et 10 ns.
1.2.6. Modes de retard	Agrandissement identique à l'agrandissement de base de temps principale.	
	— Retard	La base de temps retardée démarre immédiatement après le temps de retard.
	ou	la base de temps retardée déclenche après le temps de retard.
	— ΔT (intervalle)	La base de temps retardée démarre alternativement après le premier et le second retard.
	1/T	Temps d'intervalle ou de retard.
	— Événements avant BTR	La base de temps retardée est déclenchée après le comptage d'un certain nombre d'événements.
	— Événements avant BTP	La base de temps principale est déclenchée après le comptage d'un certain nombre d'événements.
	— Événements avant BTP combiné avec retard ΔT ou 1/T	La base de temps principale est déclenchée après le comptage d'un certain nombre d'événements
	Retard, ΔT , 1/T	Variable entre 0X et 10X le coefficient de temps de BTP.
	Résolution du réglage	5.10^{-4} de 10x réglage BTP
Jitter	1 : 30.000	

Désignation	Spécification		Information supplémentaire
Accuracy	Delay	ΔT	1/T
	$\pm 1\%$ d'échelle	$\pm 1\%$ de l'indication	$\pm 1\%$ de l'indication
	$- A\text{ }^{\circ}/_{\text{oo}}$ d'échelle	$- A\text{ }^{\circ}/_{\text{oo}}$ d'échelle	$- A\text{ }^{\circ}/_{\text{oo}}$ d'échelle*
	+ retard initial: 20 ns	$\pm 0,25\text{ }^{\circ}/_{\text{oo}}$ d'échelle	$\pm 0,25\text{ }^{\circ}/_{\text{oo}}$ d'échelle
* A dépend du réglage MTB Time/Div. A = 1,5 aux positions commençant avec 5 A = 0,5 aux positions commençant avec 1 A = 0 aux positions commençant avec 2 Erreur supplémentaire à positions 50 ns/div et 100 ns/div de MTB: $\pm 3\%$ et $\pm 1\%$ respectivement.			
Stabilité à long term	2 div. à 1000x	Rapport entre balayage BTP et BTR 1000.	
ΔT	Variable entre 0x et 10x le coefficient de temps de la BTP.	Le temps (ΔT) entre les deux BTR's est indiqué à l'affichage LED à 4 (ou 3) digits avec exposant. Le retard est lu en secondes ou, si la commande continue BTP n'est pas en position CAL, en divisions. Le second balayage retardé ne peut être réglé avant le premier. Si la somme du temps de retard et ΔT excède le temps de balayage BTP total, le second balayage retardé ne dépassera pas le balayage BTP, mais il se maintiendra à la fin de ce balayage. La valeur réelle de ΔT est mise en mémoire. Donc, si le temps de retard est diminué de telle sorte que retard et temps ΔT sont inférieurs au temps de balayage BTP, le second balayage retardé quittera à nouveau sa position en fin du balayage BTP.	
1/T	L'affichage LED indique la valeur inversée du temps de retard ou du temps ΔT .	1/T est lu en Hz à 4 digits avec exposant de dix. Si la commande continue BTP n'est pas en position CAL, l'affichage LED indique UNCAL 3.	
	Distance minimale entre marqueurs: 0,1 div. 1 div.	x1 Agrandissement x10. Si la distance est plus petit l'affichage LED indique UNCAL 2.	

Désignation	Spécification	Information supplémentaire
Evénements avant BTR	Le nombre d'événements peut être réglé entre 0 et 99999.	Le nombre d'événements est continûment réglable par potentiomètre SET. La vitesse du compteur est proportionnelle à l'angle de rotation du potentiomètre et variable entre 1 et 50 impulsions par seconde. En position enfoncée, une variation entre 100 et 5000 impulsions par seconde est possible. Si le nombre d'impulsions réglées avec le potentiomètre est supérieur au nombre affiché pour un balayage BTP unique, NOT TRIG de BTR s'allume. Si, en mode "évènements", la source de déclenchement MAIN TB est sélectionnée, l'affichage LED affiche ERROR.
Evénements avant BTP	Pour nombres d'événements conditions d'impulsions, temps de préparation, etc. voir "évènement avant BTR". Evénements avant BTP peut être combinée avec retard, ΔT ou 1/T.	Le déclenchement BTP sert à mettre le compteur en service, tandis que les impulsions à compter sont délivrées par déclenchement BTR.
Conditions d'impulsion	Taux d'événements maxi 125 MHz Largeur d'impulsion mini 4 ns Espace d'impulsion mini 4 ns	 The diagram shows a square wave signal. The period of the signal is labeled as 4 ns. The pulse width (the duration of the high state) is also labeled as 4 ns.
Temps de préparation	Référer à la fig. 1.2A.	Fig. 1.1. Taux d'événements maxi 125 MHz.
1.2.7. Déviation X par YA ou YB		
Erreur de mesure	$\pm 5 \%$	Commande continue non-étalonnée 1: $\geq 2,5$.
Bande passante	0 ... 2 MHz	-3 dB sur 8 DIV.
Déviation maxi sans distortion	20 divisions	Jusqu'à 0,1 MHz
Déphasage par rapport à l'affichage Y	3° à 0,1 MHz	
1.2.8. Déviation externe X par douille EXT		
— Coefficient de déviation		
Ext.:1	50 mV/div.	Commande continue non-étalonnée 1:3 avec X AMPL; étalonnée en position extrême droite (CAL).
Ext.:10	500 mV/div	
Précision Ext.:1	$\pm 3 \%$	2% supplémentaire pour Ext.:10
Bande passante	Continu 2 MHz -3 dB sur 4 DIV 7 Hz 2 MHz -3 dB sur 4 DIV	Par couplage de déclenchement DC Par couplage de déclenchement LF ou HF.
Caractéristiques d'entrée	Mêmes que pour voies Y	
Déphasage	3° à 0,1 MHz	En comparaison de voies Y.
Linéarité	1,5 %	
Dérive	0,2 div/heure	

Désignation	Spécification	Information supplémentaire
1.2.9. Déclenchement de la base de temps principale		
Source	Interne à partir de la voie A Interne à partir de la voie B Composite A et B Intern à partir du secteur Source externe Source externe $\div 10$	Mode vertical alterné uniquement
Modes	Automatique Déclenchement Balayage simple	Fonctionnement automatique du générateur de base de temps environ 100 ms après la disparition du signal de déclenchement.
Témoin NOT TRIG'D	Indique que la base de temps principale n'est pas déclenchée. La lampe NOT TRIG'D est allumée après remise et s'éteint en fin de balayage.	
Polarité	+ ou —	
Sensibilité	Interne, meilleur que: 0,5 div jusqu'à 30 MHz 1,5 div jusqu'à 100 MHz Externe, 50 mV jusqu'à 30 MHz 150 mV jusqu'à 100 MHz Externe $\div 10$: Typique, values 10 fois supérieures par rapport à la position EXT.	Sensibilité typique en fonction de la fréquence, voir Fig. 1.4. Sensibilité typique en fonction de la fréquence, voir Fig. 1.5.
Modes de déclenchement et couplage	DC: bande totale LF interne: 0 - 30 kHz LF externe: 7 Hz - 30 kHz HF: 30 kHz - 100 MHz TTL	Réponse uniforme, en interne et en externe —3 dB —3 dB —3 dB, interne et externe Déclenchement automatique TTL; commande de niveau ne fonctionne pas.
TTL niveaux	Déclenchement interne (A, B ou Comp) Bas : +0,8 div ($\pm 0,4$ div) Haut : +2 div ($\pm 0,4$ div) Ecart : 1,2 div Déclenchement externe (EXT) Bas : +0,8 V ($\pm 0,4$ V) Haut : +2 V ($\pm 0,4$ V) Ecart : 1,2 V	Ces données s'appliquent aux tensions à la pointe de la sonde atténuatrice 1:10 connectée à la douille d'entrée EXT.
Gamme de niveau	Déclenchement : 24 div. Déclenchement externe : +1,2 V à —1,2 V Externe $\div 10$: +12 V à —12 V	
Caractéristique d'entrée	Mêmes que pour voies Y.	
Instabilité de déclenchement	< 0,5 ns.	

Désignation	Spécification	Information supplémentaire
1.2.10. Déclenchement de la base de temps retardée		
Source	Interne à partir de la voie A Interne à partir de la voie B Externe Base de temps principale	Les autres données sont identique à celles de la déclenchement de la base de temps principale; excepter EXT ÷10 LINE trig.
Témoin NOT TRIG'D	Indique que la base de temps retardée n'est pas déclenchée.	
1.2.11. Sortie d'étalonnage		
Tension	3 V _{CC}	Par bouche de courant
Courant	6 mA	
Erreur limite	± 1 %	
Frequence	2 kHz ± 2 %	
Protection	La sortie est protegée contre des courts-circuits même continus.	
1.2.12. Entrées/sorties supplémentaires		
Modulation Z	Couplé en continu Compatible TTL Temps de réponse 35 ns Impédance d'entrée 10 kΩ Tension maximale d'entrée 50 V	Haut niveau donne un affichage sombre
Porte base de temps principale	+5 V délivrée pendant le balayage de base de temps principale autrement "0".	Impédance de sortie 1 kΩ
Porte de base de temps retardée	+5 V délivrée pendant le balayage de base de temps retardée autrement "0".	Impédance de sortie 1 kΩ
1.2.13. Alimentation		
Tensions secteur	100-127 V alternatif ± 10 % 220-240 V alternatif ± 10 % 250 V continu - 350 V continu	Protégé automatiquement contre le réglage incorrect du sélecteur secteur La position du sélecteur n'importe pas.
Fréquence secteur	46 à 440 Hz	
Consommation	60 W	
Fusible secteur incorporé	2 A retardée	Sur le panneau arrière.
Transitoire secteur	Dans des conditions de transitoire tension et fréquence spécifiée dans MIL-T-28800, l'oscilloscope ne subira aucun dommage.	

Désignation	Spécification	Information supplémentaire
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1.2.14. Conditions ambiantes

Les données relatives aux conditions ambiantes ne sont valables que si l'instrument est contrôlé conformément aux méthodes officielles. Des renseignements sur ces méthodes et sur les critères employés sont fournis sur demande par l'organisation Philips de votre pays ou par le TEST AND MEASURING DEPARTMENT de la N.V. PHILIPS' GLOEILAMPENFABRIEKEN à EINDHOVEN, PAYS-BAS.

- *Tests de température*
Conformément à C.E.I. 68 Ab et Bb.
Gamme limite d'utilisation: -15 °C ... +55 °C. Les exceptions au tolérances sont indiquées par spécification.
Gamme limite d'utilisation: -15 °C ... +55 °C..
Conditions de stockage de transport: -40°C ... +70°C, testé de -55°C à +75°C.
- *Altitude*
Conformément à C.E.I. 68-2-13, test M.
En fonctionnement: 5000 m;
Déviation: 1 °C/300 m pour température maximale.
Hors fonctionnement: 17000 m.
- *Humidité*
Conforme à C.E.I. 68 Db, selon le test standard d'oscilloscope.Philips. Une comparaison doit être faite avec MIL-E-1640F 5 cycles (120 heures).
- *Chocs.*
En fonctionnement: 30 g, demi-sinus, durée 11 ms; 2 chocs par axe dans chaque direction, total 12 chocs.
- *Vibration*
En fonctionnement: 15 min. dans chacune des trois directions.
0,7 mm déplacement crête-à-crête (4 g à 55 Hz) à fréquence 10 Hz- 55 Hz - 10 Hz en cycles d'une minute.
- *Temps de rétablissement*
30 minutes si la température de l'instrument passe de -10 °C à +20 °C sous humidité relative de 60 %.
- *Blindage magnétique*
Conformément à C.E.I. 351-22.3.1.
Déviation maxi: 1 div.
- *Interférence électromagnétique*
Conformément à VDE 0871 et 0875, Störgrad K.

1.2.15. Caractéristiques mécaniques

Dimensions	Longueur	460 mm	Commandes, couvercle et pieds non compris.
	Largeur	316 mm	
	Hauteur	154 mm	
Poids	10,7 kg.		

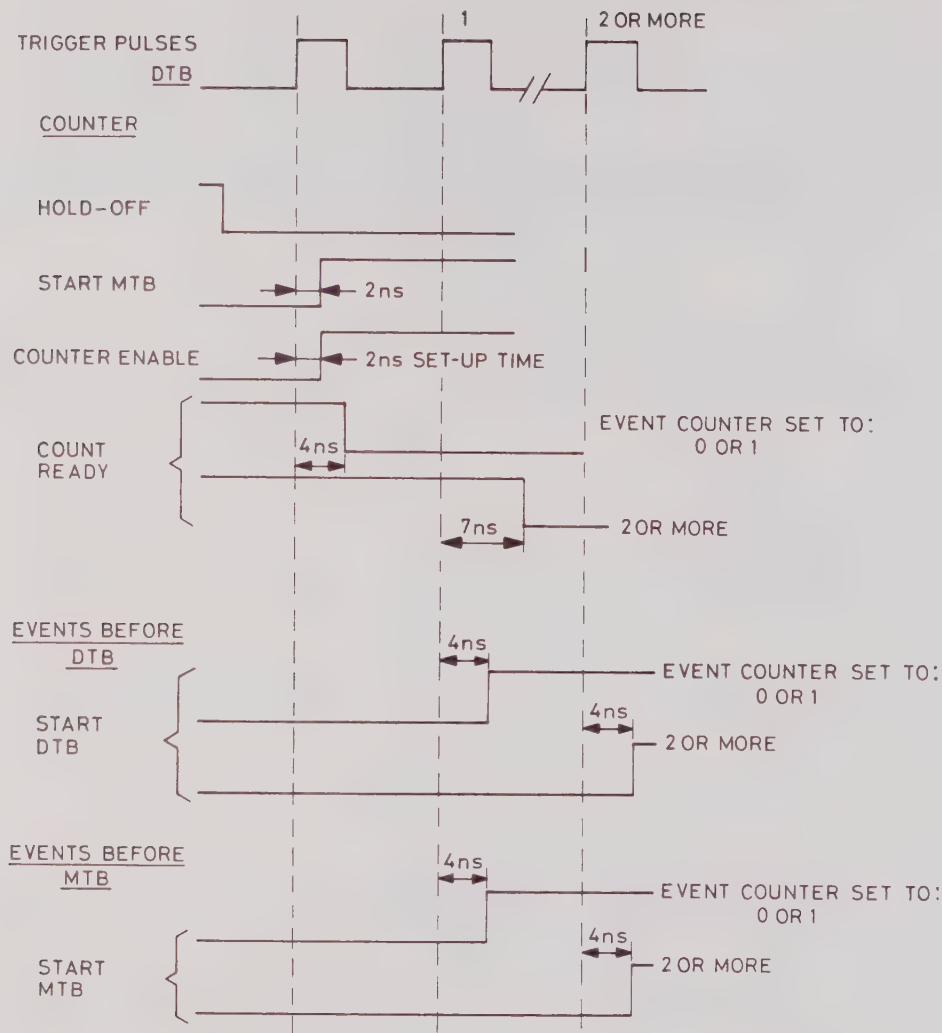
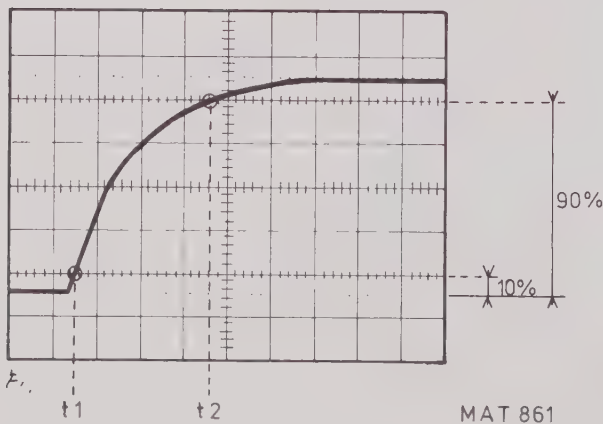


Fig. 1.2A Temps de préparation

MAT 202



MAT 861

Fig. 1.2B Mesurage du temps de montée $t_R = t_2(90\%) - t_1(10\%)$

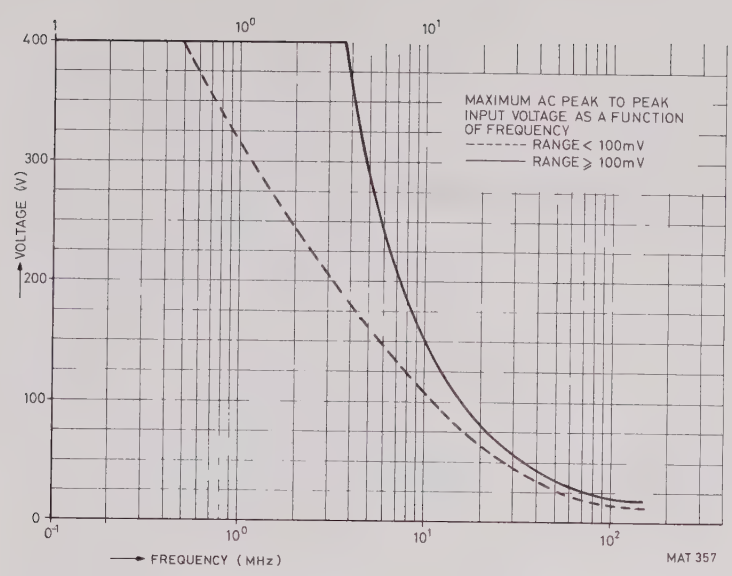


Fig. 1.3. Réductions de la tension d'entrée maximale admise en fonction de la fréquence

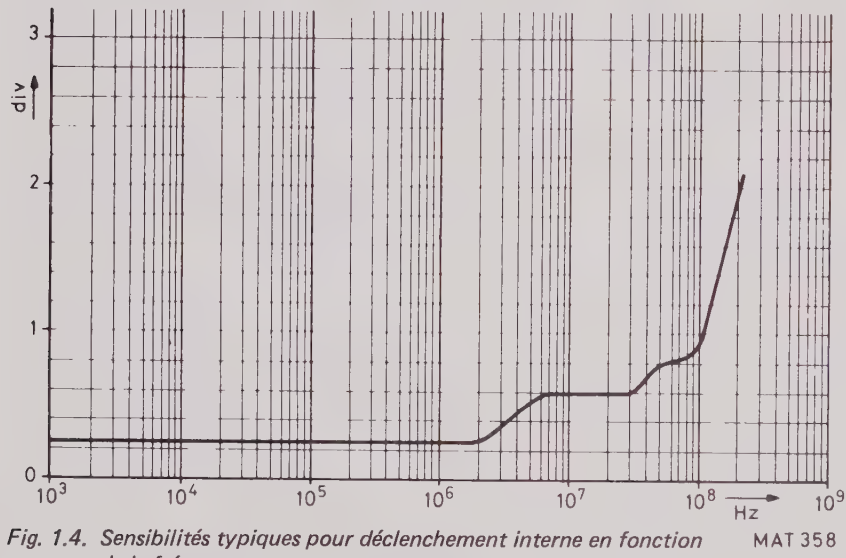


Fig. 1.4. Sensibilités typiques pour déclenchement interne en fonction de la fréquence

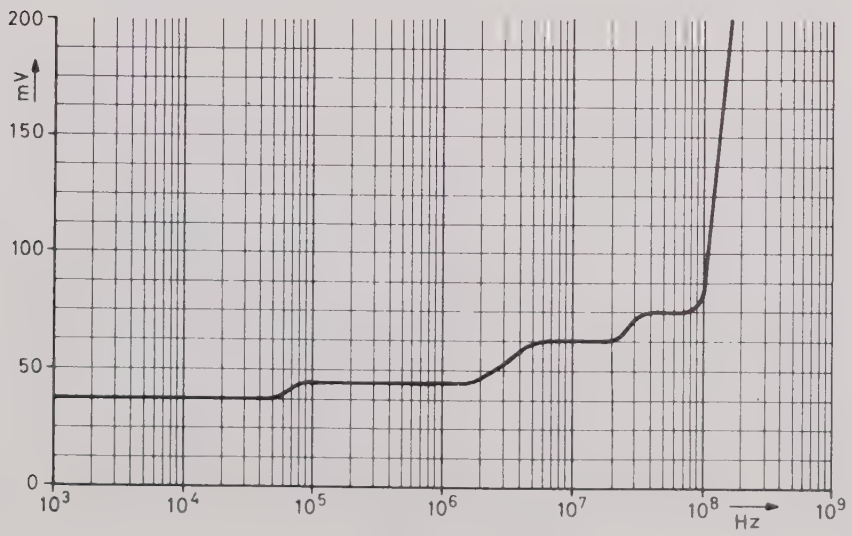


Fig. 1.5. Sensibilités typiques pour déclenchement externe en fonction de la fréquence

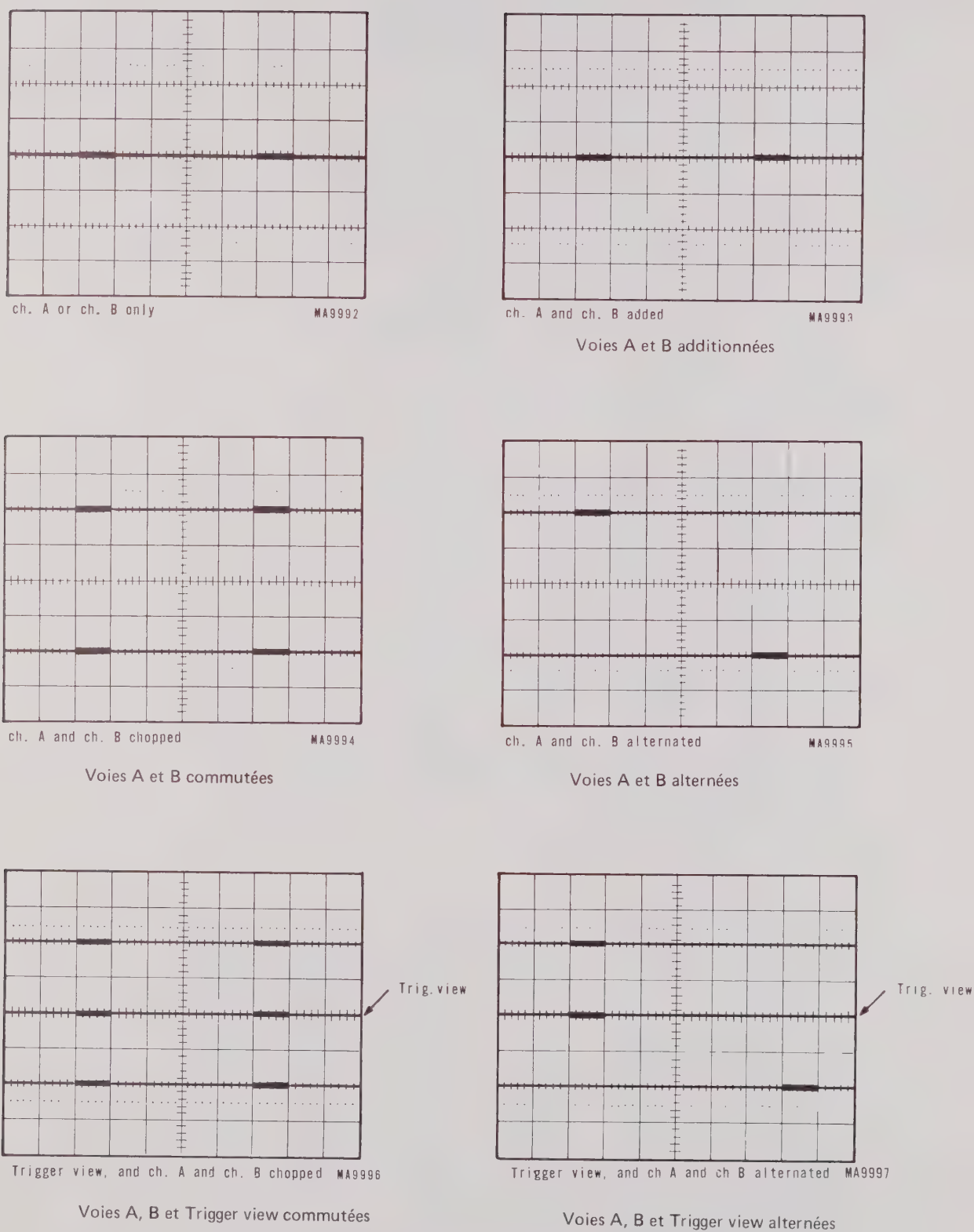


Fig. 1.6. Sommaire des possibilités d'affichage avec la base de temps retardée double

1.3. ACCESSOIRES LIVRES AVEC L'APPAREIL

- Deux sondes passives 10:1
- Filtre de contraste
- Couvercle frontal avec emplacement pour sondes, par exemple
- Visière pliante PM9366
- Adaptateur BNC banane PM9051
- Adaptateur BNC borne CAL
- Notice d'emploi et d'entretien

1.4. INFORMATIONS CONCERNANT LES SONDES 10:1 LIVRES AVEC L'APPAREIL

La sonde d'atténuation 10x est conçue pour les oscilloscopes travaillant en temps réel jusqu'à 250 MHz, comprenant un jack d'entrée BNC et une capacitance d'entrée de $13\text{pF} \pm 3\text{pF}$ avec $1\text{ M}\Omega$ en parallèle.

1.4.1. Caractéristiques techniques

Caractéristique électriques

Atténuation	$10\text{x} \pm 2\%$ (entrée d'oscilloscope $1\text{ M}\Omega \pm 1\%$)
Résistance d'entrée en continu en alternatif	$10\text{ M}\Omega \pm 2\%$ (entrée d'oscilloscope $1\text{ M}\Omega \pm 5\%$) Voir courbe Fig. 1.7.
Capacitance d'entrée en continu et basse fréquence	$11\text{pF} \pm 1\text{pF}$ (entrée d'oscilloscope $1\text{ M}\Omega \pm 5\%$ mis en parallèle par $13\text{pF} \pm 3\text{pF}$)
Réactance d'entrée HF	Voir courbe Fig. 1.7.
Largeur de bande	La sonde n'a pas effet sensiblement à largeur de bande d'oscilloscope
Tension maximale d'entrée	500V continu + alternatif (crête), décroissant avec la fréquence. Voir Fig. 1.4. Entrée d'oscilloscope $1\text{ M}\Omega$ et tension appliquée entre pointe de sonde et la partie du corps de sonde mise à la terre. Tension d'essai 1500V continu pendant 1 s à une température entre 15 et 25°C, humidité relative de 80% maximum et au niveau de la mer.
Contrôle du zéro sur boîtier de sonde	Fonction identique à la position 0 du commutateur de couplage d'entrée sur l'oscilloscope

Conditions d'ambiance

La sonde fonctionne conformément aux spécifications dans les conditions suivantes:

Température	-25 à +70°C
Altitude	Jusqu'à 5000 mètres
Autres conditions d'ambiance	Identiques à celles d'application pour l'oscilloscope utilisé avec la sonde

Caractéristiques mécaniques

Dimensions

Corps de sonde 103 mm x 10 m dia (max.)
Longueur de câble 1500 ou 2500 mm
Boîte de correction 55 x 30 x 15 mm y compris BNC

Masse

125g, y compris les accessoires standard

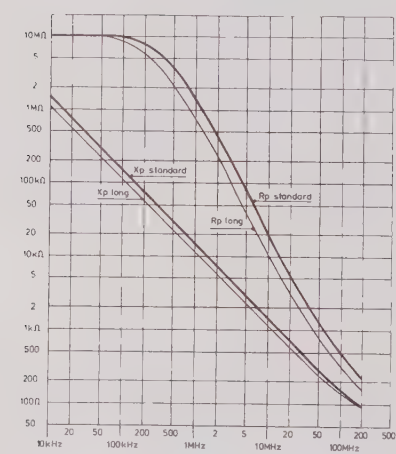


Fig. 1.7. Résistance d'entrée (R_p) et réactance (X_p) par rapport à la fréquence

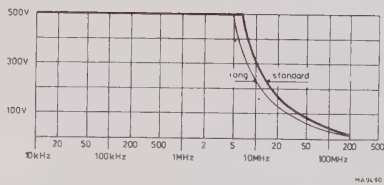


Fig. 1.8. Réglage de tension d'entrée maximale par rapport à la fréquence

1.4.2. Réglages

Adaption de la sonde à l'oscilloscope

La sonde de mesure est réglée et contrôlée par la fabricant. Cependant, pour adapter la sonde à l'oscilloscope, le procédé suivant est requis.

Connecter la pointe de mesure à la prise CAL d'oscilloscope.

Un trimmer (C2) est réglable à travers une ouverture dans la boîte de compensation pour obtenir une réponse rectangulaire optimale. Voir Fig. 1.9b.

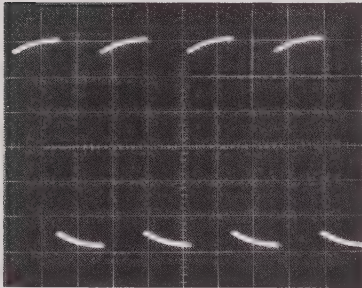


*Fig. 1.9a Surcompensation
(réglage C2)*

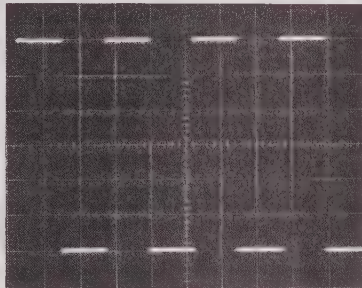


*Fig.1.9b Compensation exacte
(réglage C2)*

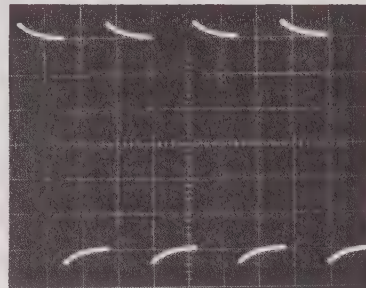


*Fig. 1.9c Sous-compensation
(réglage C2)*

Réglage de la réponse haute fréquence

Le réseau de correction pour réponse haute fréquence est réglé par le fabricant afin d'être adapté à l'entrée d'oscilloscope.

Un rajustage ultérieur ne sera nécessaire que si la sonde doit être appliquée à un oscilloscope de type différent ou après le remplacement d'un composant électrique.

Pour le réglage, procéder comme suit:

Connecter la sonde à un générateur rapide (temps de montée n'excédant pas 1 ns) terminé par son impédance caractéristiques.

Démonter la boîte de compensation. Régler le générateur sur 100 Hz. Ajuster alternativement C3, C4, R2, R4, et R5 afin d'obtenir l'affichage comme illustré en figure 1.

Il est important que le front d'onde soit aussi escarpé que possible et le sommet aussi plat que possible. Des réglages incorrects de C3, C4, R2, R4 et R5 causent des distorsions d'impulsion telles qu'illustrées aux figures 1.10b et 1.10c.

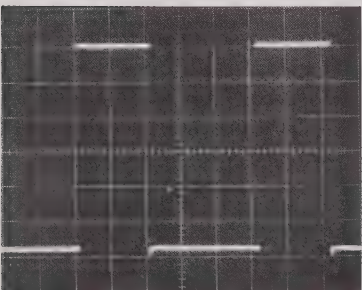


*Fig. 1.10a Potentiomètres de
pré réglage ajustés
correctement*

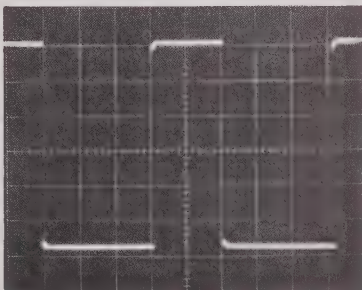


*Fig. 1.10b Arondissement dû
au réglage incorrect
des potentiomètres*

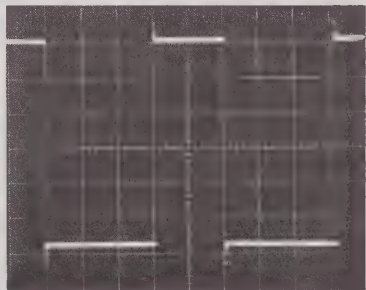


*Fig. 1.10c Dépassement dû
au réglage incorrect
des potentiomètres*

1.4.3. Démontage

Démontage de la sonde (voir Fig. 1.11)

La partie avant 11 de la sonde peut être dévissée de la partie arrière 13. Le poste 11 peut dès lors être glissé de 12 et 13.

La combinaison RC 12 est soudée à 13. Pour le remplacement de 12, se référer à la section "Remplacement des composants".

Démontage de la boîte de compensation (Fig. 1.12)

Dévisser le collier strié de la boîte de compensation au câble.

Le boîtier 14 peut être glissé latéralement de la boîte de compensation. Les composants électriques sur le circuit imprimé sont alors accessibles.

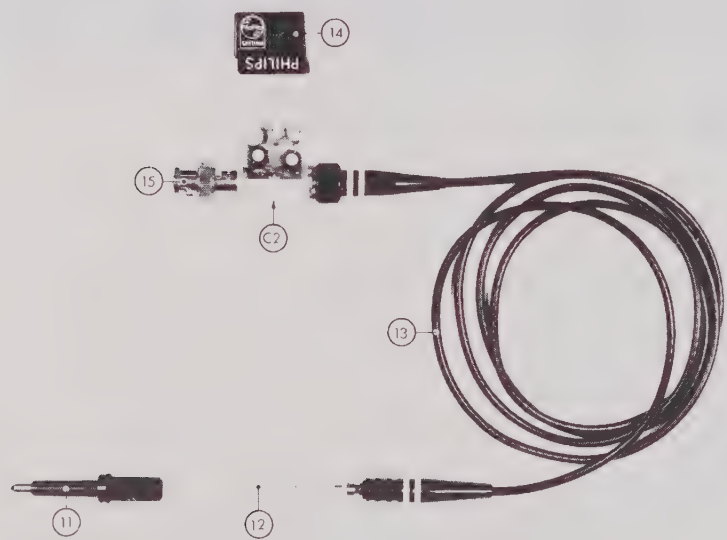


Fig. 1.11 Démontage de la sonde

1.4.4. Remplacement des composants

Assemblage de la sonde

Un nouveau réseau RC est coulissé sur le raccord de câble après quoi le conducteur de câble est soudé au fil de la résistance.

Lorsque la sonde est assemblée, le réseau RC doit se trouver au centre dans la pointe de sonde.

Remplacement du câble

Démonter la boîte de compensation.

Dessouder la connexion entre le conducteur interne et le circuit imprimé. Bien tenir le châssis de la boîte de compensation et desserrer le raccord de câble à l'aide d'une clé hexagonale de 5 mm. Pour l'assemblage, procéder en ordre inverse du démontage.

Remplacement de la pointe de sonde

La pointe endommagée peut être tirée hors de la sonde à l'aide d'un pince. Une nouvelle pointe doit être poussée fermement en place.

1.4.5. Nomenclature des composants

1.4.5.1. Composants mécaniques (Fig. 1.11. et 1.12.)

Les postes 1 à 10 sont des accessoires standard livrés avec la sonde.

Pos.	Numéro de commande	Qté	Description
1	5322 321 20223	1	Câble de terre
2	5322 256 94136	1	Porte-fusible
3	5322 255 44026	5	Bornes à souder pouvant être incorporés dans les circuits comme points de test de routine
4	5322 532 64223	2	Bague rouge
5	5322 532 74224	2	Bague blanche
	5322 532 64225	2	Bague bleue (pas illustrée)
6	5322 268 14017	2	Pointe de sonde
7	5322 462 44319	1	Capuchon isolant couvrant la partie métallique de la sonde pendant les mesures sur des circuits à câblage dense
8	5322 462 44318	2	Capuchon facilitant la mesure sur des circuits intégrés "dual-in-line"
9	5322 264 24018	1	Adaptateur enroulé
10	5322 264 24019	1	Grippe-fil à ressort
11	5322 264 24012	1	Coquille de sonde avec bouton de test zéro
12	5322 216 54152		Réseau RC
13	5322 320 14063		Ensemble de câbles
14	5322 447 64015	1	Capuchon
15	5322 268 44019	1	Connecteur BNC

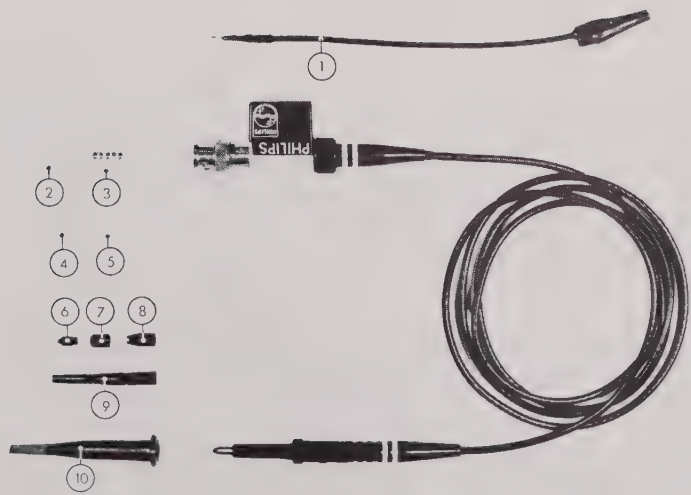


Fig. 1.12 Composants mécaniques de la sonde

1.4.5.2. Composants électriques (Fig. 1.13)

Pos	Numéro de commande	Description
C1	—	Partie du réseau RC (pas fournie séparément)
C2	5322 125 54003	Trimmer 60pF, 300V
C3	5322 125 50048	Trimmer 3,5pF, 300V
C4	5322 125 50051	Trimmer 18pF, 300V
L1	—	Bobinage (pas fournie)
R1	—	Partie du réseau RC (pas fournie séparément)
R2	5322 100 10135	Potentiomètre 470Ω, 20%
R3	5322 116 50536	Resistance
R4	5322 100 10135	Potentiomètre 470Ω, 20%
R5	5322 100 10143	Potentiomètre 1kΩ, 20%

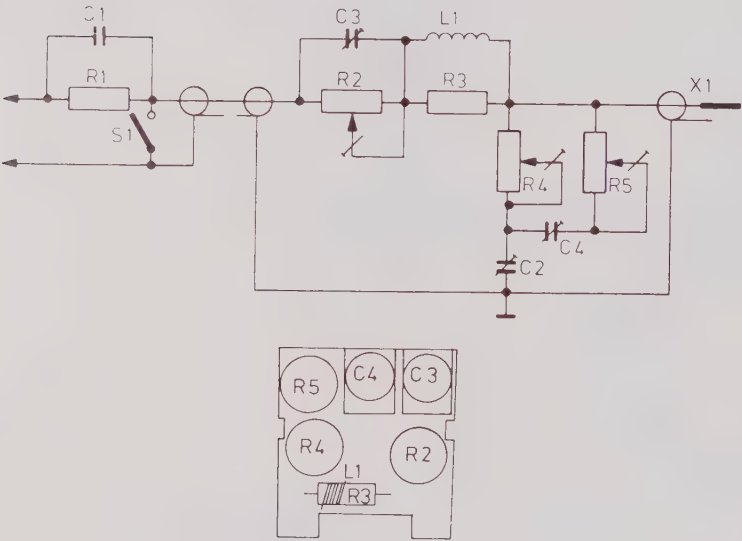


Fig. 1.13 Composants électriques de la sonde

1.5. DESCRIPTION DU SCHEMA SYNOPTIQUE DE FONCTIONNEMENT

1.5.1. Déflexion verticale

L'appareil présente deux voies identiques A et B, chacune assurant le contrôle et l'amplification des signaux pour respectivement les entrées A et B. A des fins de simplification, on ne décrit que la voie A.

La voie A (CHANNEL A) comprend un commutateur de couplage de signaux AC/O/DC, une commande AMPL/DIV pour régler l'amplification des signaux afin d'obtenir la hauteur désirée de la trace verticale, et une commande de POSITION combinée à une fonction NORMAL/INVERT. Dans les trois positions du commutateur AC/O/DC, le signal d'entrée est appliqué respectivement à l'entrée de l'amplificateur par l'intermédiaire d'un condensateur d'arrêt du courant continu (position AC), le signal d'entrée est interrompu (position O) ou le signal est envoyé directement à l'entrée de l'amplificateur (position DC). Le potentiomètre POSITION assure le contrôle rotatif continu du décalage vertical du signal sur l'écran; l'action de contrôle en push-pull permet d'afficher le signal soit en mode normal soit en mode inversé.

Le déclenchement de la base de temps sur un signal dérivé d'une des voies verticales est possible par l'intermédiaire du bloc de commutation de déclenchement composite A/B (A/B COMPOSITE TRIGGER SWITCHING).

Le commutateur VERTICAL CHANNEL SWITCH permet de commuter le signal de sortie de la voie A pour l'envoyer par la ligne de retard (DELAY LINE) et l'amplificateur vertical de sortie (FINAL VERTICAL AMPLIFIER) ou de bloquer ce signal. D'autres sources de signaux pour la ligne de retard (DELAY LINE) et l'amplificateur vertical de sortie (FINAL VERTICAL AMPLIFIER) sont le signal de sortie de la voie B ou le signal TRIGGER VIEW. Ce signal est le signal sur lequel la base de temps principale est déclenchée et il provient de la source de déclenchement de la base principale. Si les voies A et B sont commutées simultanément, les signaux de sortie de ces voies s'ajoutent et la somme est affichée sur l'écran. Le sélecteur de voie verticale (VERTICAL CHANNEL SWITCH) est commandé par la logique de mode d'affichage vertical (VERTICAL DISPLAY MODE LOGIC) qui est commandée par le sélecteur de mode d'affichage vertical A, ALT, TRIG VIEW, CHOP, ADD, B. Si plus d'une voie est affichée l'affichage peut fonctionner en mode découpé (CHOPPED) ou en mode alterné (ALTERNATE). Un signal dérivé de la base de temps principale (MAIN TIME BASE) est utilisé pour la commutation en mode alterné. La ligne de retard (DELAY LINE) assure le retard des signaux nécessaires pour permettre au flanc montant d'un phénomène rapide d'être affiché sur l'écran.

L'amplificateur vertical de sortie (FINAL VERTICAL AMPLIFIER) commande des plaques de déflexion verticale du tube cathodique. En mode alterné de la base de temps, la commande de séparation de trace (TRACE SEPARATION) permet un décalage de trace vertical réglable entre les signaux des bases de temps principale et retardée pour faciliter la comparaison.

1.5.2. Déflexion horizontale

La source d'entrée pour l'amplificateur horizontal de sortie (FINAL HORIZONTAL AMPLIFIER) peut être soit la base de temps principale (MAIN TIME BASE), soit la base de temps retardée (DELAYED TIME BASE), ou encore l'amplificateur de déflexion horizontale (HORIZONTAL DEFLECTION AMPLIFIER). La source sélectionnée dépend du réglage du commutateur de voie horizontale (HORIZONTAL CHANNEL SWITCH) qui est commandé par la logique de mode d'affichage horizontal (HORIZONTAL DISPLAY MODE LOGIC). Cette logique est commandée par le sélecteur de mode d'affichage horizontal DELD TB, ALT TB, EXT X DEFL, MAIN TB.

La base de temps principale (MAIN TIME BASE) et la base de temps retardée (DELAYED TIME BASE) sont en mesure, toutes les deux, de produire une tension en dents de scie linéaires dans le temps, dont le temps de balayage est réglable à l'aide de la commande TIME/DIV.

SOURCE DE DECLENCHEMENT DE LA BASE DE TEMPS PRINCIPALE/FILTRE/AMPLI DE DECLENCHEMENT (MAIN TIME BASE TRIGGER SOURCE/FILTER/TRIGGER AMPLIFIER):

La base de temps principale peut être déclenchée par la voie A ou B, par un signal dérivé de la tension secteur ou par un signal appliqué à l'entrée de déclenchement externe EXT TRIG OR X DEFL. La source de déclen-

chement est sélectionnée à l'aide du sélecteur de la source de déclenchement. Le signal de la source sélectionnée peut être filtré par un filtre basse fréquence, ou un filtre haute fréquence ou peut passer sans être filtré si le bouton DC du commutateur DC/LF/HF est actionné. Le niveau et la pente du signal, auxquels la base de temps est démarrée, peuvent être réglés à l'aide de la commande LEVEL/SLOPE. La source de déclenchement de la base de temps principale sélectionnée peut également servir à la déflexion horizontale par l'intermédiaire de l'amplificateur de déflexion horizontale (HORIZONTAL DEFLECTION AMPLIFIER) et à la voie de déclenchement TRIGGER VIEW par l'intermédiaire du sélecteur de voie verticale (VERTICAL CHANNEL SWITCH)

Si le mode EVENTS BEFORE MTB est sélectionné, le démarrage de la base de temps principale est déclenchée par un signal provenant du compteur d'événements (EVENT COUNTER). Voir la section 1.5.3.

SOURCE DE DECLENCHEMENT DE LA BASE DE TEMPS RETARDE/FILTRE/AMPLI DE DECLENCHEMENT (DELAYED TIME BASE TRIGGER SOURCE/FILTER/TRIGGER AMPLIFIER): la base de temps retardée (DELAYED TIME BASE) peut être déclenchée par la voie A ou la voie B ou par un signal appliqué à l'entrée de déclenchement externe (EXT TRIG). Le couplage du signal DC/LF/HF et LEVEL/SLOPE est réglable.

Le bloc repéré COMPARATOR compare la forme d'onde en dents de scie de la base de temps principale à une tension continue réglable issue du double convertisseur numérique-analogique (DUAL DIGITAL TO ANALOG CONVERTER). Cela se produit en mode retardé (DELAY) et en mode ΔT . Pour les détails voir la section 1.5.3.

A l'instant où la tension en dents de scie correspond au niveau continu réglé, le COMPARATOR envoie un signal à la base de temps retardée. Si le bouton-poussoir MAIN TB du sélecteur de source de déclenchement est actionné, la base de temps retardée démarre immédiatement. Si l'on actionne A, B ou EXT du sélecteur de source de déclenchement, la base de temps retardée démarre, après le signal provenant du comparateur (COMPARATOR), à réception d'une impulsion de déclenchement provenant de la source de déclenchement sélectionnée.

Si le mode EVENTS BEFORE DTB est sélectionné et si l'on actionne le bouton-poussoir A, B ou EXT du sélecteur de source de déclenchement de la base de temps retardée, le démarrage de la base de temps retardée est déclenché par un signal émis par le compteur EVENT COUNTER. Voir la section 1.5.3.

1.5.3. Section retard et compteur d'événements

Le coeur de cette section de l'appareil est constitué par le micro-ordinateur (MICROCOMPUTER). Ce bloc balaie séquentiellement les réglages des commandes situées sur le panneau frontal. Cela peut se faire grâce à l'interface d'entrée (INPUT INTERFACE). Selon le réglage de ces commandes, le micro-ordinateur peut activer un certain nombre de blocs qui lui sont reliés. D'abord le micro-ordinateur ajuste l'affichage à diodes électroluminescentes (LED DISPLAY) selon la valeur et la fonction sélectionnées par les commandes du panneau frontal. Si ces commandes occupent une position incorrecte, l'affichage l'indiquera.

En mode retardé, le micro-ordinateur commande le double convertisseur numérique-analogique (DUAL DIGITAL TO ANALOG CONVERTER). Ce convertisseur produit une tension continue en sortie qui est appliquée au comparateur décrit dans la section 1.5.2. Le micro-ordinateur commande le convertisseur de façon que la valeur du retard représentée sur l'affichage corresponde au retard réel entre le démarrage de la base de temps principale et de la base de temps retardée. En mode retardé (DELAY) et en mode ΔT le comparateur reçoit alternativement deux tensions continues différentes provenant du convertisseur.

- pour un balayage de la base de temps principale, une tension continue est appliquée au comparateur assurant un démarrage retardé de la base de temps à la fin du temps de retard réglé.
- pour le balayage suivant de la base de temps principale, une tension continue quelque peu plus élevée est appliquée au comparateur pour assurer le démarrage de la base de temps après le retard + le temps ΔT .

L'affichage affiche alors la valeur du temps ΔT . Si l'on actionne le bouton poussoir ΔT , le micro-ordinateur calcule la valeur de $1/\Delta T$ et veille à ce que l'affichage affiche cette valeur.

En modes EVENTS BEFORE MTB ou EVENTS BEFORE DTB, le compteur EVENT COUNTER est en fonctionnement. Le nombre d'événements/impulsions dérivés de la source de déclenchement de la base de temps retardée (DELAYED TIME BASE TRIGGER SOURCE) est compté par le compteur EVENT COUNTER. Si le nombre sélectionné d'événements a été compté, le compteur EVENT COUNTER fait démarrer la base de temps principale (en mode EVENTS BEFORE MTB) ou il fait démarrer la base de temps retardée (en mode EVENTS BEFORE DTB). Le micro-ordinateur commande le compteur EVENT COUNTER et l'affichage (LED DISPLAY) de sorte que, dès que le nombre d'événements représenté sur l'affichage a été compté, la base de temps principale ou retardée démarre.

1.5.4. Section d'affichage sur tube cathodique

L'amplificateur Z reçoit cinq signaux d'entrée qui détermine l'intensité du spot sur l'écran. Cette intensité est commandée par le "Wehnelt Cylinder" G1 du tube cathodique (CRT). Non seulement l'intensité mais aussi la focalisation du spot sur l'écran est corrigée. Il en résulte que la focalisation du spot sur l'écran ne change pas par suite d'une variation d'intensité.

Les signaux qui commandent l'intensité et la focalisation du spot sont:

- le réglage de la commande INTENS située sur la panneau frontal,
- un signal de blocage du mode d'affichage découpé provenant de la logique du mode d'affichage vertical (VERTICAL DISPLAY MODE LOGIC),
- un signal de blocage d'affichage pendant le temps HOLD OFF de la base de temps principale, signal qui est issu de la base de temps principale,
- un signal provenant du sélecteur de voie horizontal (HORIZONTAL CHANNEL SWITCH) pour la partie intensifiée du signal de base de temps retardée sur le signal de la base de temps principale,
- un signal externe qui peut être appliqué à la douille d'entrée Z-MOD.

1.5.5. Alimentation

L'alimentation secteur est stabilisée et fournit les tensions continues d'alimentation des circuits électronique de l'appareil, la haute tension positive du premier accélérateur du tube cathodique, la haute tension négative de la cathode du tube cathodique. En outre, l'alimentation fournit un signal lié à la tension secteur à des fins de déclenchement de la base de temps principale.

2. INSTALLATION

2.1. REGLEMENTS DE SECURITE (CONFORMES A LA CEI 348)

Avant de brancher l’instrument sur le secteur, examiner le boîtier, les commandes, les connecteurs, etc. afin de s’assurer qu’il n’y a pas eu de dommages en cours de transport. En cas de défauts, ne pas brancher l’instrument.

RECLAMATIONS: En cas de dommages ou d’insuffisances, ou si la sécurité de l’appareil est mise en doute, une réclamation doit être adressée directement au transporteur. De plus, il faudra également avertir une organisation de vente ou de service Philips afin de faciliter le procédé de réparation.

Avant de procéder à toute autre connection, la borne de terre de l’instrument doit être reliée à la ligne de terre du réseau (voir 2.4 mise à la terre).

REMARQUE:	L’ouverture des capots ou l’enlèvement d’organes à l’exception de ceux directement accessibles à la main, sont susceptibles de découvrir des composants et des connecteurs sous tension.
------------------	--

L’instrument doit être débranché de toute source de tension avant de procéder à un réglage, un remplacement, une opération d’entretien ou une réparation nécessitant l’ouverture de l’instrument.
Si le réglage, l’entretien ou la réparation de l’instrument ouvert sous tension sont inévitables, seule une personne qualifiée peut se charger de cette tâche.
Ne pas oublier que les condensateurs à l’intérieur de l’instrument peuvent être chargés, même si l’instrument est déconnecté de toute source de tension.

2.2. DEMONTAGE ET MONTAGE DU COUVERCLE AVANT (voir Fig. 2.1.)

Démontage:

- Tourner le bouton au centre du couvercle d’un quart de tour vers la gauche (position UNLOCKED).
- Enlever le couvercle.

Montage:

- Tourner le bouton de verrouillage vers position UNLOCKED.
- Fixer le couvercle sur la partie avant de l’oscilloscope.
- Enfoncer le bouton et le tourner d’un quart de tour vers la droite (position LOCKED).

2.3. POSITION DE L’APPAREIL

L’instrument peut être utilisé en toute position. A poignée rabattue, l’instrument peut être utilisé en position inclinée. Les spécifications conformément aux paragraphe 1.2. ne sont garanties qu’en position normale ou avec poignée rabattue (s’assurer que la grille de ventilation au-dessus et en-dessous du boîtier n’est pas obturée). Il n’est pas recommandé de placer l’instrument en plein soleil ou sur une surface produisant de la chaleur. La poignée peut être tournée en appuyant sur les boutons-poussoirs aux étriers.

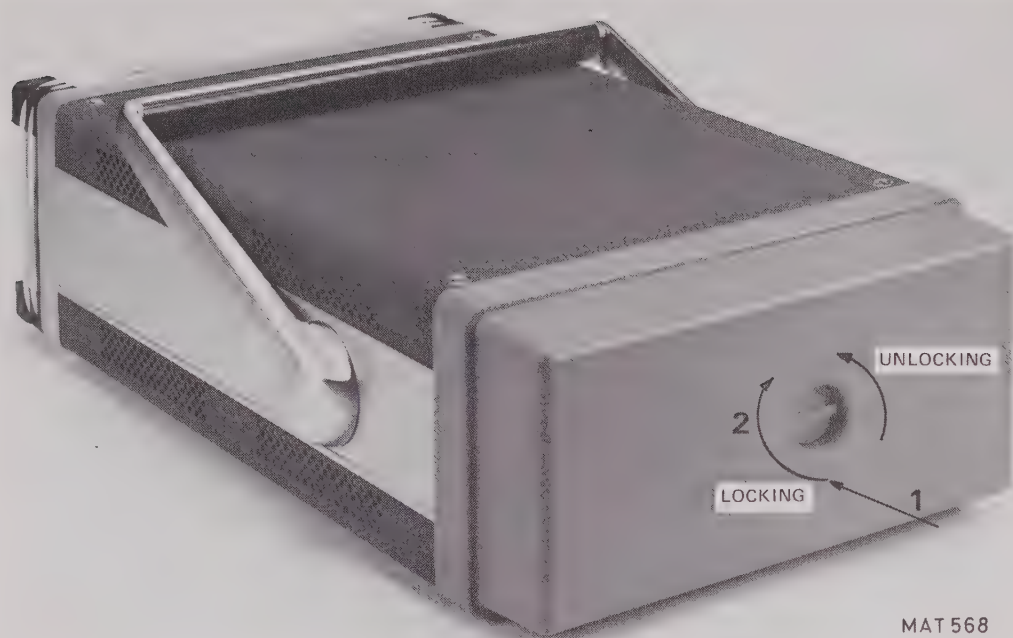


Fig. 2.1. Dépose du couvercle frontal

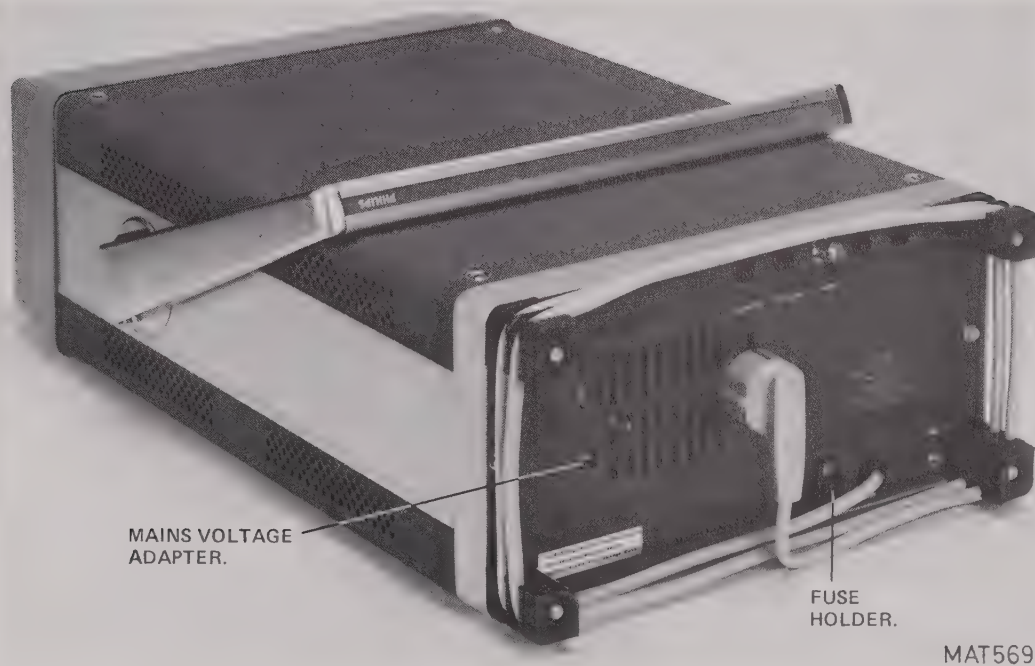


Fig. 2.2. Vue arrière de l'appareil, réglage secteur et fusible

2.4. MISE A LA TERRE

Avant toute mise sous tension, l'instrument doit être connecté à la terre.

- Par la borne de terre de l'appareil.
- Par le cordon secteur à trois conducteurs. La fiche secteur ne sera introduite que dans une prise possédant un contact de terre. La mise à la terre ne doit pas être éliminée par l'emploi d'un câble prolongateur sans conducteur de terre.

ATTENTION: Toute interruption de la ligne de terre, à l'intérieur ou à l'extérieur de l'instrument, tout débranchement de la borne de terre peut rendre l'instrument dangereux. L'interruption intentionnelle de la ligne de terre est formellement interdite.

Lorsqu'un instrument passe d'un endroit froid à un endroit chaud, la condensation peut provoquer un certain risque. En conséquence, il faut appliquer strictement les prescriptions de mise à la terre.

2.5. ADAPTATION A LA TENSION SECTEUR ET FUSIBLE

Avant de raccorder le secteur, s'assurer que l'instrument est réglé sur la tension secteur locale.

L'appareil peut fonctionner sur deux gammes de tension secteur 100 ... 127 V en alternatif ($\pm 10\%$) et 220 ... 240 V en alternatif ($\pm 10\%$). Cette dernière gamme est également sélectionnée pour le fonctionnement en continu entre 250 et 350 V. La sélection de gamme se fait à l'aide du commutateur coulissant situé derrière la fenêtre à l'arrière de l'appareil. La gamme sélectionnée est visible par cette fenêtre, voir fig. 2.2.

Toujours déconnecter l'appareil de toute source de tension avant d'accéder au sélecteur de gamme.

Le sélecteur est accessible après dépose du panneau arrière (fixé par 2 vis).

L'appareil est protégé contre le réglage incorrect du sélecteur de gamme secteur.

Le porte-fusible monté sur le panneau-arrière porte un fusible lent de 2A.

En cas de remplacement, les fusibles de rechange seront correctement calibrés et d'un modèle adéquat.

Il faut éviter d'utiliser des fusibles réparés ou de court-circuiter des porte-fusibles. En cas de remplacement d'un fusible ou d'adaptation à une autre tension secteur, l'instrument sera débranché de toute source de tension.

3. INSTRUCTIONS D'UTILISATION

3.1. GENERALITES

La présente section décrit les travaux et précautions requises à l'utilisation. En outre, elle décrit sommairement les fonctions des commandes et des indicateurs et met en évidence les aspects pratiques du fonctionnement. De la sorte, un opérateur peut rapidement se familiariser avec les fonctions principales de l'instrument.

3.2. ENCLenchement

Lorsque l'instrument est branché au secteur comme indiqué aux paragraphes 2.4 et 2.5, il peut être enclenché à l'aide du bouton poussoir POWER. Le commutateur POWER est incorporé dans la commande d'illumination de graticule ILLUM (panneau avant), immédiatement sous le bord de l'écran. Le témoin POWER ON/OFF est proche de la commande ILLUM.

L'instrument est immédiatement en état de fonctionner, après enclenchement. Les caractéristiques techniques selon le paragraphe 1.2 ne sont valables que dans une situation normale — conforme à la section 2 — et après un temps d'échauffement de 30 min.

ATTENTION: L'instrument ne doit jamais être enclenché lorsqu'une platine ou un bloc a été enlevé. Ne déposer de platine ou de bloc qu'une minute au moins après la mise hors service de l'instrument.

3.3. TEST INITIAL ("power-on")

A la mise en circuit, le microprocesseur démarre un test automatique des circuits interne y compris:

- test processeur
- test prom
- test ram
- test affichage

Le résultat de ces tests est indiqué sur l'affichage LED.

Un  apparaît de gauche à droite à chaque digit pendant 0,5 sec.

Ensuite, les témoins EV, DIV et S ou Hz s'allument pendant 0,5 sec.

Si les circuits contrôlés par le microprocesseur ne fonctionnent pas proprement, les résultats suivants sont indiqués sur l'affichage LED:

- L'affichage reste vierge:
test processeur négatif
-  en position extrême droite:
test prom négatif
- / en position extrême droite:
test ram négatif

3.4. DESCRIPTION DES COMMANDES ET CONTROLES

3.4.1. Déviation verticale et section TRC

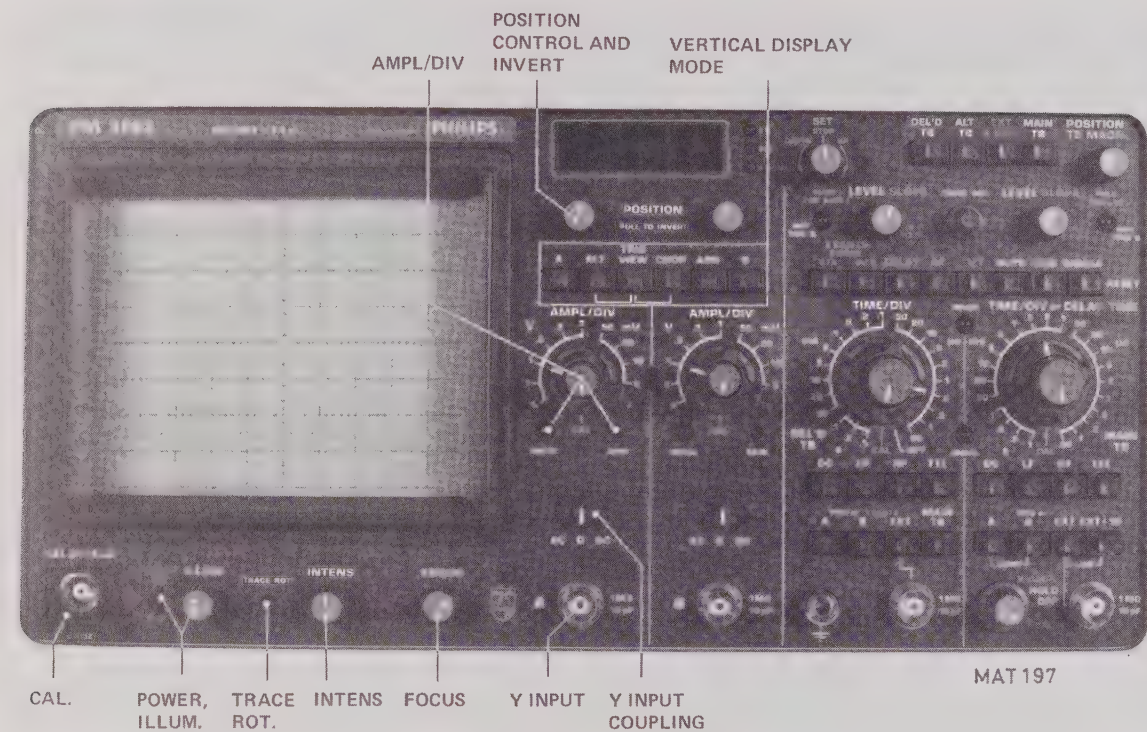


Fig. 3.1. Déviation verticale et section TRC

— Mode d’affichage vertical	Commandes du mode d’affichage vertical, sélecteur à 6 boutons-poussoirs.
poussoir A enfoncé	La déviation verticale est obtenue seulement par le signal appliqué à l’entrée de la voie A.
poussoir ALT enfoncé	L’affichage est permuté d’une voie vertical à l’autre, et ce à la fin de chaque cycle du signal de base de temps; les voies A et B sont représentées sur les balayages ALT.
poussoir TRIG VIEW enfoncé	L’affichage est commuté pour visualiser le signal de déclenchement sélectionné. Il peut être interne par les voies A ou B ou externe. L’affichage Trig View peut être combiné avec l’affichage ALT ou CHOP.
poussoir CHOP enfoncé	L’affichage est permuté d’une voie verticale à l’autre à une fréquence fixe, les deux voies étant affichées sur le même balayage.
poussoir ADD enfoncé	La déviation verticale est obtenue par la somme des signaux A et B.
poussoir B enfoncé	La déviation verticale est obtenue seulement par le signal appliqué à l’entrée de la voie B.
poussoirs ALT et TRIG VIEW enfoncés simultanément	Les signaux sur voies A, B et TRIG VIEW sont affichés pendant les balayages alternés; normalement appropriés pour des signaux haute fréquence. (voir aussi explication bouton-poussoir TRIG VIEW).
poussoirs CHOP et TRIG VIEW enfoncées simultanément	Les signaux sur voies A, B et TRIG VIEW sont affichés successivement à la fréquence CHOP pendant le même balayage normalement appropriés pour des signaux basse fréquence. (voir aussi explication bouton-poussoir TRIG VIEW).
Tous les poussoirs relâchés	Si aucun bouton-poussoir n’est enfoncé, l’appareil fonctionne en mode ALT.

—		
	POSITION	Commande continûment variable pour décadrage vertical de l’affichage.
	PULL TO INVERT	Commutateur tirette intégré à la commande POSITION, pour inversion de la polarité du signal. La polarité est inversé en position tirée.
	AMPL/DIV	Commande échelonné à 11 positions des coefficients de déviation verticale. En position 2 mV/DIV, la largeur de bande est limitée à 35 MHz.
	CAL (AMPL/DIV)	Commande continuellement variable des coefficients de déviation verticale. En position CAL le coefficient de déviation est étalonné.
	UNCAL	Lampe témoin indiquant que la commande CAL n’est pas en position étalonnée.
	GAIN (accessible par tournevis)	Commande continuellement variable du gain en position CAL.
—	Couplage d’entrée Y	
	AC, 0, DC	Mode de couplage du signal d’entrée; commutateur à trois positions.
	AC	Couplage par l’intermédiaire d’un condensateur de liaison.
	0	La connexion entre l’entrée de l’amplificateur et la prise d’entrée est interrompue et l’entrée de l’amplificateur est mise à la terre.
	DC	Couplage direct.
—	Entree	
	A 1 MOhm - 15 pF	Prise d’entrée BNC pour voie A
	B 1 MOhm - 15 pF	Prise d’entrée BNC pour voie B
—	Section TRC	
	CAL	Sortie délivrant une tension rectangulaire 3 V _{CC} , 2 kHz pour étalonner la commande AMPL de déviation vertical ou pour compenser la fréquence des sondes du diviseur de tension. Boucle de courant avec 6 mA _{CC} pour l’étalonnage des sondes de courant.
	ILLUM, POWER ON	Commande continuellement variable de l’illumination de graticule; comprend le commutateur secteur.
	POWER ON	Lampe témoin indiquant que l’appareil est branché au secteur.
	TRACE ROT (accessible par tournevis)	Commande de pré-réglage pour aligner la trace avec les lignes de graticule.
	INTENS	Commande continuellement variable pour la brillance de la trace.
	FOCUS	Commande continuellement variable pour la focalisation du faisceau.

3.4.2. Déviation horizontale



Fig. 3.2. Déviation horizontale

— Mode d’affichage horizontal

poussoir DEL’D TB enfoncé

Commandes du mode d’affichage horizontal; par commutateur à 4 boutons-poussoirs.

poussoir ALT TB enfoncé

La déviation horizontale est fournie par le générateur de base de temps retardée.

L’affichage horizontal est permuté de la base de temps principale en base de temps retardée à la fin de chaque cycle, etc.

poussoir EXT X DEFL enfoncé

Quand ALT TB est combiné avec TRIG VIEW, l’affichage MAIN TB est présenté.

La déviation horizontale peut être obtenue par un signal d’origine extérieure appliqué à la prise d’entrée de l’amplificateur horizontal, par le signal de voie A, par le signal de voie B ou par un signal à la fréquence du secteur, en fonction de la sélection TRIG ou X DEFL.

poussoir MAIN TB enfoncé

La tension de déviation horizontale est fournie par le générateur de base de temps principale.

Une partie de la trace est intensifiée (sauf en position OFF du commutateur TIME/DIV du générateur de base de temps retardée).

Si aucun bouton n’est enfoncé

On obtient le même effet que lorsque le bouton MAIN TB est enfoncé.

POSITION TB MAGN

Commande continuellement variable pour le positionnement horizontal des traces; cette commande comprend un commutateur push-pull qui augmente le coefficient de déviation horizontale d’un facteur 10 (PULL FOR X10).

TRACE SEP

Commande de pré-réglage continûment variable de l'espace vertical entre les deux affichages de base de temps en mode ALT TB.

— Sélecteur de déviation

Sélecteur de déviation externe X ou sélecteur de source de déclenchement BTP.

La déviation X uniquement lorsque le bouton EXT X DEFL du sélecteur d'affichage horizontal est enfoncé.

A enfoncé

Déviation X interne de la voie A.

B enfoncé

Déviation X interne de la voie B.

EXT enfoncé

Le signal à l'entrée externe est utilisé à la déviation X.

EXT ÷ 10 enfoncé

Identique au précédent à la différence que le signal passe par un diviseur de tension incorporé 1:10.

LINE (EXT et EXT÷10 enfoncé)

Déviation X interne de la tension réseau.

— EXT DEFL INPUT

Douille d'entrée pour déviation X externe.

— X AMPL

Commande variable de l'amplitude de déviation X en mode EXT X DEFL combiné avec la commande de blocage. Normalement ce bouton est en position CAL.

3.4.3. Base de temps principale

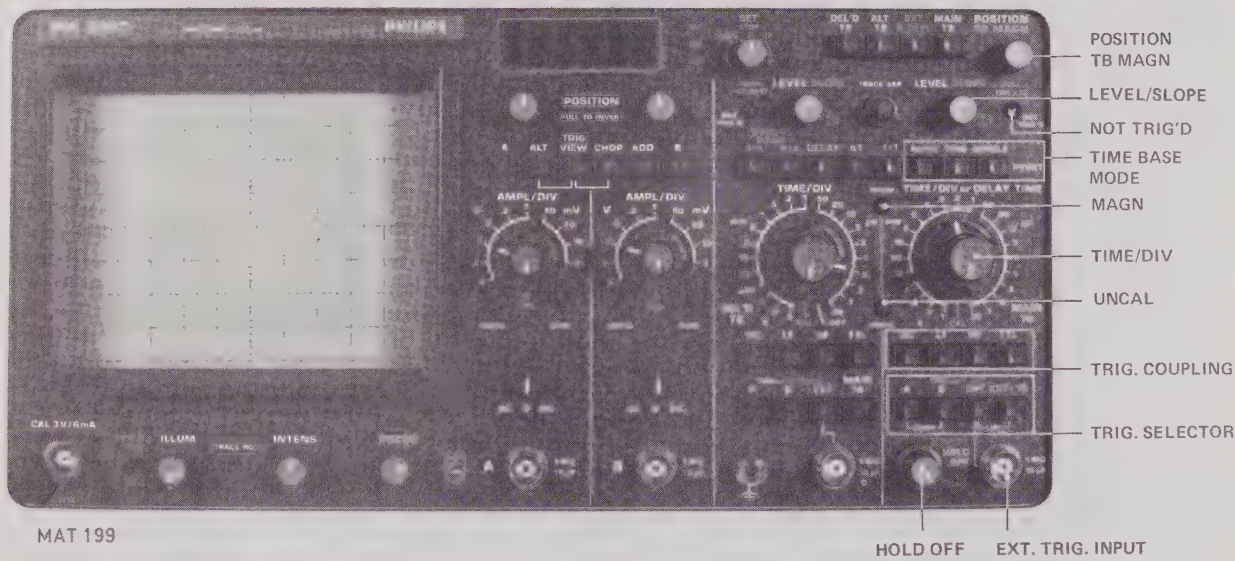


Fig. 3.3. Base de temps principale

TB MAGN	Commutateur push-pull pour augmenter le coefficient de déviation horizontale d'un facteur 10 (PULL FOR X10).
LEVEL SLOPE	Commande continuellement variable pour sélectionner le niveau du signal de déclenchement, auquel le générateur de base de temps principale démarre. Cette commande comprend un commutateur push-pull, qui permet de déclencher sur le front positif ou négatif du signal de déclenchement (enfoncé "+", tiré "-").
NOT TRIG'D	Lampe témoin qui s'allume lorsque le générateur de base de temps principale est en position d'attente.
— AUTO, TRIG, SINGLE	Commande de mode de déclenchement; commutateur à trois boutons-poussoirs.
poussoir AUTO enfoncé	Le générateur de base de temps principale est en fonctionnement libre en l'absence de signaux de déclenchement.
poussoir TRIG enfoncé	Le générateur de base de temps est déclenché normalement.
poussoir SINGLE (RESET) enfoncé	Le générateur BTP, est en mode de balayage simple. A la réception d'une impulsion de déclenchement, le générateur ne démarre qu'une seule fois. Si on enfonce une nouvelle fois ce bouton, la BTP est remise à zéro en vue de l'impulsion de déclenchement suivante. Si aucun bouton n'est enfoncé, l'appareil fonctionne en mode SINGLE.
— MAGN	Une lampe témoin indiquée x10 s'allume lorsque cette loupe est utilisée; pour bases de temps principale et retardée.

– TIME/DIV	Commande de la vitesse de balayage de la base de temps principale; commutateur rotatif à 23 positions.
CAL (blue) (TIME/DIV)	Commande continuellement variable de la vitesse de balayage de la base de temps principale. En position CAL, la vitesse de balayage est étalonnée).
UNCAL	Lampe témoin indiquant que la commande CAL n'est pas en position étalonnée; pour BTP et BTR.
– COUPLAGE DE DECLenchement	Commutateur 4 voies (type bouton-poussoir)
DC	Pleine largeur de bande (continu compris).
LF	Couplage par le filtre passe-bas pour des fréquences allant de continu jusqu'à 30 kHz (de 7 Hz à 30 kHz pour déclenchement externe, par filtre passe-bande).
HF	Couplage par un filtre passe-haut pour des fréquences supérieures à 30 kHz.
TTL	Déclenchement automatique aux niveau TTL. Commande de réglage continuellement de niveau hors de service.

Si aucun bouton-poussoir n'est enfoncé, on obtient le même effet que si la touche DC était enfoncée.

TRIG SELECTOR	Bouton-poussoir à 4 voies.
Sélecteur de déclenchement	Sélecteur de déclenchement externe X ou sélecteur de source de déclenchement BTP. La déviation X uniquement lorsque le bouton EXT X DEFL du sélecteur d'affichage horizontal est enfoncé.
A enfoncé	Déclenchement X interne de la voie A.
B enfoncé	Déclenchement X interne de la voie B
COMP (A et B enfoncés)	Déclenchement X interne des voies A et B; seulement dans le mode Y alternative.
EXT enfoncé	Déclenchement sur signal externe par douille d'entrée adjacente.
EXT÷10 enfoncé	Identique au précédant à la différence que le signal passe par un diviseur de tension incorporé 1:10.
LINE (EXT et EXT÷10 enfoncés)	Déclenchement X interne de la tension réseau.

Si aucun bouton n'est enfoncé, le circuit fonctionne comme si le bouton A était enfoncé.

EXT TRIG INPUT	Entrée pour déclenchement externe.
HOLD OFF	Ce bouton permet de commander le temps de blocage de la BTP et donc le déclenchement parfait par exemple sur des signaux à double impulsion. Normalement ce bouton est en position CAL. Au plus on l'éloigne de cette position, au plus le temps de blocage augmente. Combiné avec le bouton X AMPL variable.

3.4.4. Base de temps retardée

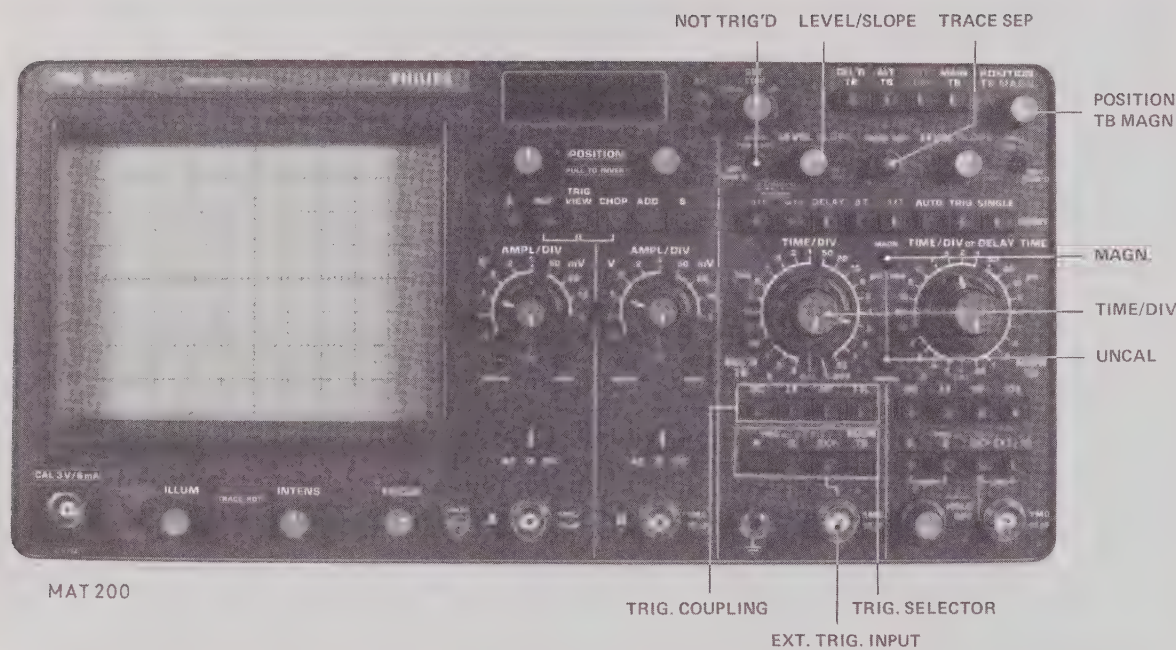


Fig. 3.4. Base de temps retardée

POSITION TB MAGN	Commande continuellement variable pour le positionnement horizontal des traces comprend un commutateur push-pull qui augmente le coefficient de déviation horizontale d'un facteur 10 (PULL FOR X10).
TRACE SEP	Commande continûment variable de séparation entre les deux affichages de base de temps en mode ALT TB.
LEVEL-SLOPE	Commande continuellement variable qui permet de sélectionner le niveau du signal de déclenchement auquel le générateur de base de temps retardée démarre. Cette commande comprend un commutateur push-pull qui permet de démarrer sur le front positif ou négatif du signal de déclenchement ("+"enfoncé, "-" tiré).
NOT TRIG'D	Témoin indiquant que le générateur BTP est en position d'attente.
MAGN	Témoin X10 indiquant que cette loupe est utilisée (pour BTP et BTR).
TIME/DIV	Commande du coefficient de temps pour base de temps retardée; commutateur rotatif à 23 positions. Comprend une position OFF, grâce à laquelle le générateur de base de temps retardée est déclenché.
CAL (bleu) (TIME/DIV)	Commande continuellement variable du coefficient de temps de la base de temps retardée. En position CAL, le coefficient de temps du commutateur est étalonné.
UNCAL	Lampe témoin indiquant que la commande CAL n'est pas en position étalonnée.

- COUPLAGE DE DECLENCHEMENT
 - DC Bouton-poussoir à 4 voies.
Pleine largeur de bande (continu compris)
 - LF Couplage par un filtre passe-bas pour les fréquences jusqu'à 30 kHz (pour le déclenchement par un signal extérieur, le filtre passe-bas agit de 7 Hz à 30 kHz).
 - HF Couplage par un filtre passe-haut pour fréquences supérieures à 30 kHz.
 - TTL Déclenchement automatique aux niveaux TTL.
Commande de réglage continuellement de niveau hors de service.

Si aucun bouton n'est enfoncé, on obtient le même effet que si le bouton DC était enfoncé.
- TRIG SELECTOR
 - A enfoncé Déclenchement interne sur voie A après temps de retard.
 - B enfoncé Déclenchement interne sur voie B après temps de retard.
 - EXT enfoncé Déclenchement sur signal externe après temps de retard par l'intermédiaire de la douille d'entrée de déclenchement externe adjacente.
 - MAIN TB enfoncé La base de temps retardée démarre immédiatement après le temps de retard.

Si aucun bouton n'est enfoncé, le circuit fonctionne comme si le bouton A était enfoncé.
- EXT TRIG INPUT
 - Entrée pour déclenchement externe.

3.4.5. Compteur d'événements et retard

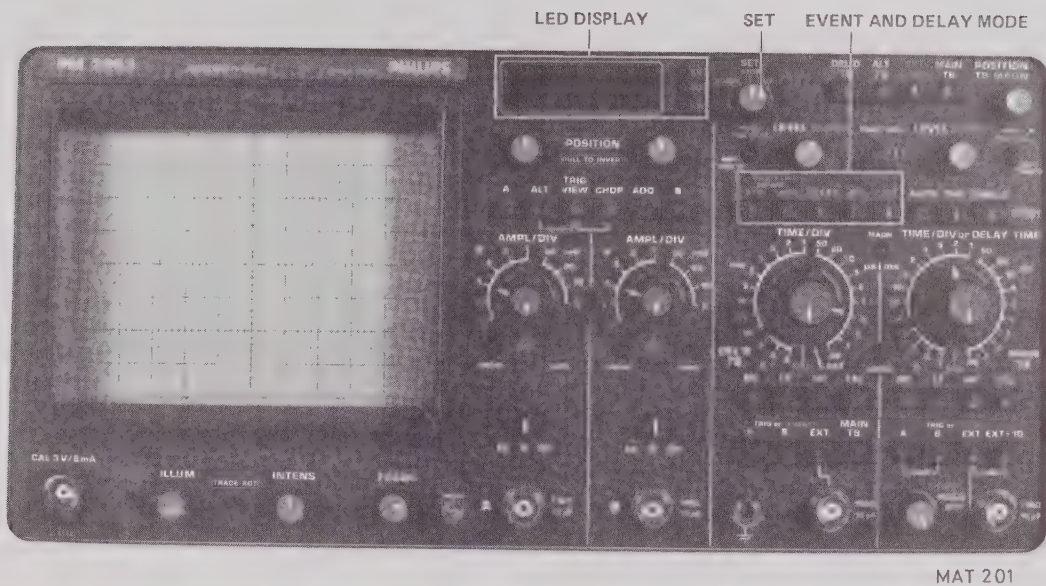


Fig. 3.5. Compteur d'événements et retard

— Affichage LED	EV allumé	Nombre d'événements (impulsions) à compter est affiché.
	DIV allumé	Nombre de divisions de l'affichage du TRC en mode DELAY et en mode ΔT est affiché, lorsque le vernier MAIN TB n'est pas en position CAL.
	S ou Hz allumé	Un temps est affiché si le bouton 1/T n'est pas enfoncé, tandis que la fréquence est affichée si ce bouton est enfoncé.
	Bouton de réglage (SET)	Contrôle le nombre d'événements à compter en mode de comptage d'événements. Contrôle le temps DELAY et le temps d'intervalle ΔT dans les mode respectifs.
— Sélecteur d'événements (EVENTS) et de mode de retard (DELAY)		
	EVENTS BEFORE DTB	Le compteur d'événements est utilisé au retard de la base de temps retardée.
	EVENTS BEFORE MTB	Le compteur d'événements est utilisé au retard de la base de temps principale.
	DELAY	La base de temps retardée démarre un certain temps après le démarrage de la base de temps principale. Ce temps est réglable à l'aide du bouton SET.
	ΔT (Intervalle)	Double base de temps retardée. Le temps d'intervalle entre les deux balayages de temps retardé est réglable à l'aide du bouton SET et affiché sur l'affichage LED. Utilisé pour les mesures de temps entre deux points d'un signal complexe.
	1/T	Si le temps DELAY ou ΔT est égal à une période du signal la fréquence du signal est affichée sur l'affichage LED.

3.5. QUELQUES INFORMATIONS SUR LES PRINCIPES DE FONCTIONS DU PM 3263

3.5.1. Entrées A et B

L'oscilloscope est pourvu de deux voies identiques, toutes deux pouvant être utilisées soit pour des mesures YT avec un ou deux générateurs de base de temps, soit pour des mesures XY avec la voie horizontale externe.

Mesures YT

Pour afficher un signal d'une des voies verticales, il suffit d'actionner le bouton-poussoir A ou B des commandes de mode d'affichage vertical.

Lorsque le bouton-poussoir ALT ou CHOP est enfoncé, deux signaux différents peuvent être affichés simultanément. Le coefficient de déviation Y et la polarité peuvent être sélectionnés pour chaque voie séparément. Lorsque le bouton ALT est actionné, l'affichage est commuté d'une voie à l'autre au retour du signal de base de temps.

Quoique le mode ALT puisse être utilisé à toutes les vitesses de balayage du générateur de base de temps, le mode CHOP donne une meilleure qualité d'affichage pour longs temps de balayage. En effet pendant les temps de balayage longs, l'affichage alterné des deux signaux d'entrée est visible.

En mode CHOP, l'affichage est permuté d'une voie à l'autre à une fréquence fixe.

Si le bouton-poussoir ADD du commutateur de mode d'affichage est actionné, les signaux des deux voies verticales sont additionnés. En fonction des positions des commutateurs de polarité, la somme ou la différence des signaux d'entrée est affichée. Le mode ADD permet également des mesures différentielles.

Lorsque les commutateurs de polarité des deux voies sont mis en positions opposées, les parties mode commun des signaux aux prises A et B subissent une très légère amplification par rapport aux parties de mode différentiel.

Mesures XY

Si les boutons-poussoirs EXT X DEFL des commandes de déviation horizontale et A des commandes TRIG OR X DEFL sont actionnés, les générateurs de base de temps sont déconnectés. Un signal appliqué à la voie verticale A est alors utilisé pour la déviation horizontale. Le commutateur AC/0/DC et l'atténuateur par échelons de la voie A restent en service. La commande continue des coefficients de déviation est possible avec la commande X DEFL/HOLD OFF et le décadage de la trace horizontale avec la commande X POSITION.

La voie verticale B peut également être utilisée pour la déviation X. Pour ce faire, le bouton B des commandes TRIG OR X DEFL doit être enfoncé.

Pour la déviation X, il est également possible d'utiliser une tension interne à la fréquence secteur ou un signal extérieur appliqué à la douille EXT située sur la partie inférieure droite du panneau, après avoir enfoncé le bouton-poussoir correspondant des commandes TRIG OR X DEFL. Dans ces modes, la largeur de trace peut être commandée avec le potentiomètre X DEFL/HOLD OFF.

Lorsque ce potentiomètre est en position CAL, le coefficient de déviation pour un signal extérieur est de 50 mV/DIV.

Le signal externe peut être couplé en continu ou en alternatif (fréquence inférieure 7 Hz) en enfonçant le bouton DC ou LF des commandes de déclenchement de la base de temps.

Commutateur AC/0/DC

Les signaux observés sont appliqués aux prises d'entrées A et/ou B et le commutateur AC/0/DC est réglé soit sur AC soit sur DC en fonction de la composition du signal. Du fait que l'amplificateur vertical est couplé directement, tout la bande passante de l'appareil est disponible et les composantes continues sont affichées comme des décalages de trace en position DC du commutateur AC/0/DC. Ceci peut ne pas convenir lorsque de petits signaux superposés à des tensions continues doivent être représentés. Chaque atténuation du signal résulte en une atténuation de la petite composante alternative.

Le remède à cet état est d'utiliser la position AC du commutateur d'entrée, lequel comprend un condensateur de liaison servant à supprimer les signaux continus et basse fréquence. Lorsque des signaux rectangulaires à basse fréquence sont représentés, on obtient une certaine pente de toit.

En position 0 le signal est interrompu et l'entrée de l'amplificateur est mise à la terre, sur cette position, le niveau 0 V est rapidement déterminé.

3.5.2. Base de temps

Les circuits de base de temps délivrent une tension en dents de scie en vue de la déviation horizontale linéaire. La vitesse de déviation horizontale est calibrée de telle sorte qu'on obtient un affichage exact et en rapport au temps.

Pour obtenir un affichage stable, la tension en dents de scie de la base de temps doit être démarrée chaque fois au même point de l'onde (encore appelé "déclenchement").

Base de temps principale

La base de temps principale comporte trois modes:

- AUTO** : Le générateur de base de temps est en fonctionnement libre en l'absence de signaux de déclenchement.
Dès qu'un signal de déclenchement est présent, un affichage stable est obtenu.
- TRIG** : Le générateur de base de temps ne fonctionne que lorsqu'un signal de déclenchement est présent.
En cas d'absence de signal de déclenchement, l'affichage reste sombre.
- SINGLE** : Le générateur de base de temps ne fonctionne qu'une seule fois à la réception d'une impulsion de déclenchement. Ce mode est souvent utilisé pour photographier des phénomènes uniques.
Après un balayage simple la base de temps est préparée en vue de la réception de l'impulsion de déclenchement suivante, et ce en enfonçant à nouveau le bouton SINGLE.

Blocage variable

Le temps de blocage est le temps qui s'écoule entre la fin d'un balayage de la base de temps et le moment auquel le circuit est prêt à déclencher à l'impulsion de déclenchement suivante.

En cas de signaux composés (par ex. signaux à double impulsion), le double déclenchement peut en résulter et conséquemment un affichage instable. Afin d'éviter ce déclenchement double, le temps de blocage peut être réglé à l'aide de la commande HOLD OFF.

En position CAL de ce même bouton, le temps de blocage est minimal.

Base de temps retardée

Le générateur de base de temps retardée est en principe identique au générateur de base de temps principale. Cependant, ce générateur fonctionne seulement pendant le balayage de la base de temps principale.

La base de temps retardée est généralement utilisée pour une inspection plus détaillée de signaux complexes. Si le bouton DEL'D TB est enfoncé, seule la base de temps retardée est affichée.

Lorsque le bouton MAIN TB de la source de déclenchement BTR est enfoncé, le balayage de BTR démarre à un certain moment pendant le balayage de la base de temps principale.

Etant donné que le rapport entre temps de balayage BTP et BTR peut être élevé, quelque jitter peut apparaître au seul affichage de la base de temps retardée. Ce jitter peut être supprimée en déclenchant la base de temps retardée par A, B ou EXT. Le temps lu sur l'affichage LED n'est dès lors plus précis, alors UNCAL 1 est indiqué. L'oscilloscope PM 3263 propose une base de temps retardée double (mode ΔT). Deux balayages de base de temps retardée sont possibles sur un balayage de base de temps principale. Le balayage de la base de temps retardée est généralement sur un court temps afin d'obtenir une fonction de marquage.

Le temps de retard et le temps ΔT peut être lu sur l'affichage LED.

Autre nouveauté: l'oscilloscope PM 3263 déclenche après le comptage d'événements, et ce soit en base de temps principale, soit en base de temps retardée. Le nombre d'événements (impulsions) peut être réglé entre 0 et 99999.

Le compteur d'événements ne compte que les impulsions de déclenchement présentes dans le circuit de déclenchement de BTR.

Le compteur d'événements commence à compter à la réception d'une impulsion de déclenchement de la BTP.

Agrandisseur de base de temps MAGN

L'agrandisseur de base de temps est actionné par un commutateur push-pull à deux positions incorporé dans la commande POSITION horizontale. Lorsque ce commutateur est tiré en position x10, les vitesses de balayage du générateur de base de temps principale sont augmentées d'un facteur 10. Donc, en x1 (TB MAGN enfoncé) la portion du signal affichée sur une largeur égal à une division au centre de l'écran occupe la largeur totale de l'écran en position X10. Chaque portion de la trace peut être rapportée sur l'écran à l'aide de la commande de POSITION horizontale.

En position x10, le coefficient de temps est déterminé en divisant par 10 la valeur TIME/DIV.

Avec TB MAGN enclenché, l'affichage LED n'est pas modifié (x1).

Utilisation de la base de temps alternée (ALT TB)

Le PM 3263 est équipé d'une commutation d'affichage. De ce fait, l'utilisateur obtient un affichage simultané du signal sur les deux échelles de temps, l'un provenant de la base de temps principale et l'autre de la base de temps retardée.

Une portion de l'affichage de la base de temps principale peut être examinée en détail en allongeant l'intervalle de temps en question à l'aide de la base de temps retardée. Cette expansion est obtenue en sélectionnant un balayage plus rapide de la commande TIME/DIV de la base de temps retardée.

La portion de signal détaillée par la base de temps retardée demeure portion intensifiée de l'affichage de base de temps principale. Ceci ne facilite pas seulement le détail lors du réglage, mais il sert aussi d'indication visuelle. L'observateur peut comparer directement le détail avec le signal total (peut-être très complexe) sans devoir commuter entre MAIN TB et DEL'D TB.

Le décadage vertical entre les deux affichages de base de temps est continûment variable à l'aide de la commande TRACE SEP.

3.5.3. Déclenchement

Lorsqu'un signal doit être représenté, le(s) générateur(s) de base de temps doit (doivent) toujours être démarré(s) à un point fixe du signal, et ce afin d'obtenir une trace stationnaire. Le générateur de base de temps est donc démarré par des impulsions de déclenchement étroites produites dans l'unité de déclenchement et commandé par un signal qui peut provenir: d'un des signaux appliqués aux entrées verticales, d'une tension interne à la fréquence du secteur, ou d'une source extérieure.

Les impulsions de déclenchement sont produites dans l'unité de déclenchement en comparant le signal d'entrée avec une tension continue réglable (LEVEL).

Le niveau de déclenchement est rapporté au taux de déviation verticale en cas de déclenchement interne (A ou B) et à la tension d'entrée en cas de déclenchement externe (EXT).

Couplage de déclenchement

Quatre méthodes de couplage de déclenchement sont possibles avec le commutateur DC/LF/HF/TTL. En positions HF et LF, la caractéristique de transfert est limitée.

En position DC, le signal de déclenchement reste inchangé.

En position LF, un filtre passe-bande de 0 Hz (7 Hz pour déclenchement externe) à 30 kHz est incorporé.

Cette position peut être utilisée pour réduire l'interférence du bruit.

En position HF, un filtre passe-haut de 30 kHz est incorporé.

Cette position peut être utilisée pour réduire l'interférence du ronflement par exemple.

En position TTL on obtient un déclenchement automatique sur niveaux TTL.

L'espace de déclenchement est alors de valeur fixe (la commande LEVEL ne fonctionne pas).

Source de déclenchement

Le signal de déclenchement est obtenu à partir de la voie A ou B (source interne) ou d'une source externe par la douille EXT. En cas de déclenchement interne le signal de déclenchement n'est pas affecté par la commande continue AMPL.

Base de temps principale

La base de temps principale peut être également déclenché par un circuit atténuateur 1:10 permettant ainsi des tensions supérieures de déclenchement externe.

Le déclenchement composite est choisi en enfonceant les deux boutons A et B.

Dans ce mode, le signal de déclenchement est prise de la voie A ou B en fonction de la voie affichée.

A noter que le déclenchement composite n'est pas applicable dans le mode CHOP, parce que la tension CHOP est alors traitée comme tension de déclenchement.

Le déclenchement secteur (= déclenchement par un signal dérivé de la tension secteur) est sélectionné en enfonceant les boutons EXT et $EXT \div 10$.

3.5.4. Micro-processeur

Ses tâches principales consistent à:

- Vérifier la position des commandes de panneau avant.
- Charger l'affichage LED
- Charger le compteur d'événements
- Charger le convertisseur digital-analogique afin d'obtenir la tension de comparateur pour BTR.
- Calculer la valeur $1/T$.

3.6. REGLAGES PRELIMINAIRES

3.6.1. Etalonnage GAIN

- Actionner le bouton-poussoir A des commandes de mode d'affichage.
 - Actionner le bouton-poussoir AUTO des commandes de mode de déclenchement.
 - Actionner le bouton-poussoir MAIN TB des commandes de déviation horizontale.
 - Centrer la trace avec la commande POSITION appropriée.
 - Régler les commandes INTENS et FOCUS afin d'obtenir une trace nette et fine.
 - Régler le commutateur AC-0-DC sur DC.
 - Régler le commutateur AMPL sur .5 V et la commande continue sur CAL (étalonnée).
 - Connecter la prise d'étalonnage CAL à la prise d'entrée A.
 - Vérifier si la hauteur de trace est exactement de 6 divisions.
- Au besoin, rajuster la commande GAIN sur le panneau avant, juste sous le commutateur AMPL.

Si une sonde atténuatrice 1:10 utilisée, régler le commutateur d'amplitude sur 50 mV/DIV.

Vérifier la réponse rectangulaire de la sonde.

Répéter cette opération pour la voie B.

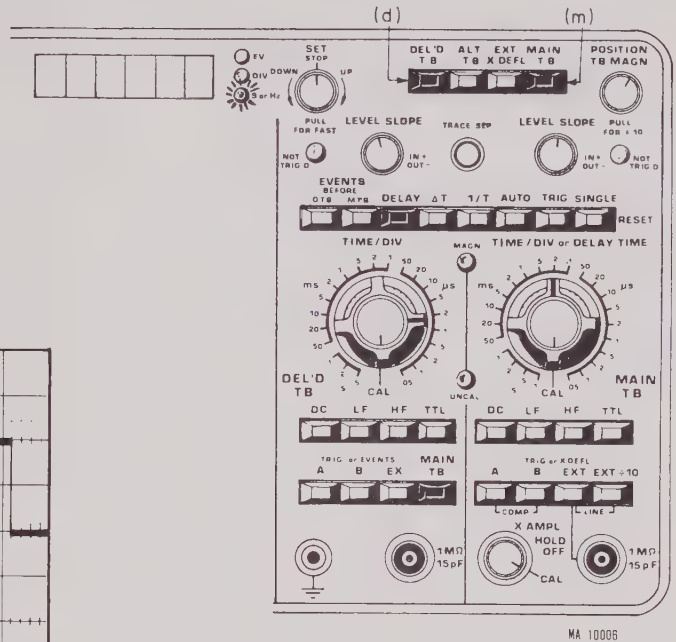
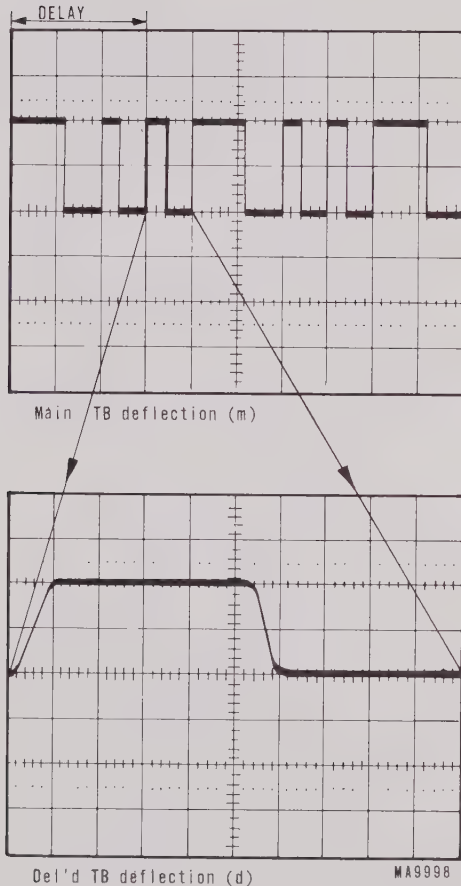
3.6.2. Rotation de trace

- Enfoncer le bouton-poussoir A des commandes de mode d'affichage.
- Enfoncer le bouton-poussoir MAIN TB des commandes de déviation X.
- Centrer la ligne de base de temps à l'aide des commandes POSITION.
- Vérifier si la ligne de base de temps est parfaitement parallèle aux lignes de graticule horizontales; au besoin, rajuster la commande TRACE ROT sur le panneau avant.

3.7. INFORMATION DETAILLEES SUR LES MODES "RETARD" ET "COMPTEUR D'EVENEMENTS"

3.7.1. Mode "DELAY" (retard)

Dans ce mode les bases de temps principale et retardée fonctionnent toutes deux. Le balayage de la BTR est intensifié pendant le balayage de BTP.



Le temps de retard après lequel la base de temps retardée démarre est lu sur l'affichage LED.

L'affichage indique une maintisse et un exposant de dix.

L'exposant peut être sombre (0), -3 ou -6, ce qui signifie respectivement secondes, millisecondes et microsecondes.

Le temps de retard est commandé à l'aide du bouton SET.

Dans les versions précédentes cette commande se faisait à l'aide d'un bouton calibré 10-tours indiquant un facteur entre 0 et 100 % par lequel il fallait multiplier le balayage BTP pour obtenir le temps de retard.

Le nouveau système permet de lire directement le temps de retard sur l'affichage.

Lorsque la déviation DEL'D TB (d) est sélectionnée, le balayage de BTR représenté sur l'affichage TRC tout entier. De cette manière le point de démarrage de la BTR peut être exactement réglé afin de lire

avec précision optimale le temps de retard lu sur l'affichage LED. A noter que la valeur maximale lue sur l'affichage est égale au temps de balayage total de BTP.

Comme décrit la base de temps retardée est démarrée en un certain point^{*)} du balayage de la base de temps principale, quelque jitter peut apparaître. Pour obtenir un affichage TRC sans jitter, la base de temps retardée peut être déclenchée par sélection A, B ou EXT; cependant, l'affichage LED indique UNCAL 1.

LED DIV

Lorsque le vernier MAIN TB n'est pas en position CAL, l'affichage LED ne peut indiquer le temps DELAY; cependant, le retard est indiqué en nombre de divisions sur l'affichage.

Dans ce cas, le témoin "DIV" est allumé et "S or Hz" éteint.

TB MAGN

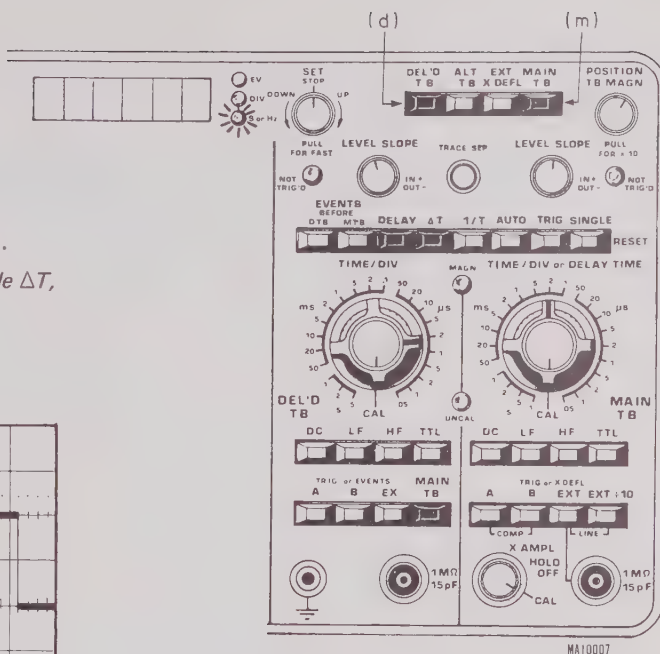
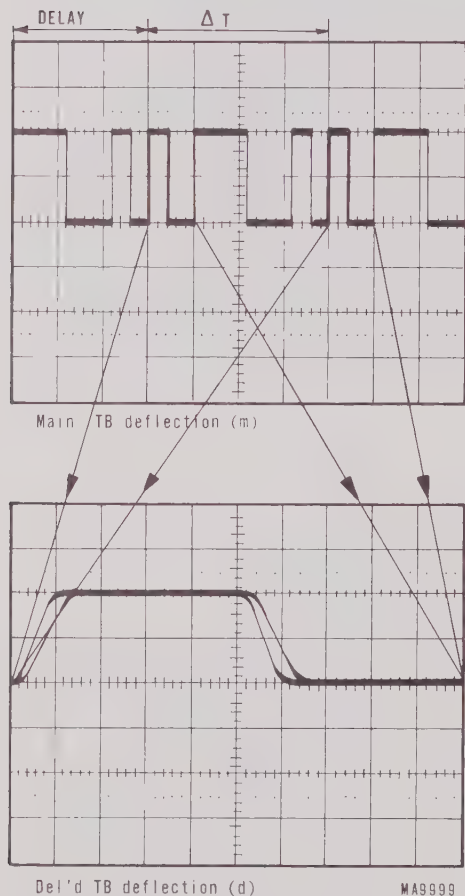
Si TB MAGN est actionné; l'affichage LED n'est pas modifié et reste donc en affichage x1.

^{*)} En fait, la tension en dents de scie de la BTP est comparée à une tension continue dérivée de l'affichage LED.

3.7.2. Mode "DELAY" et ΔT

Ce mode est une extension du mode DELAY. Lorsque le bouton ΔT est enfoncé, on obtient l'affichage TRC des deux balayages de base de temps retardée pendant le balayage de la base de temps principale^{*)}.

Remarque: A la sélection initiale du mode ΔT , les deux marqueurs de BTR coïncident.



ΔT est le temps qui s'écoule entre les points de démarrage des différents balayages de base de temps retardée sur l'affichage TRC.

Le mode ΔT convient aux mesures de temps sur des signaux complexes. Les deux balayages de base de temps retardée sont utilisés comme marqueurs.

Le temps de retard et ΔT peuvent tous deux être commandés à l'aide du bouton SET.

En cas de déviation DEL'D TB (d) les deux balayages retardés sont représentés sur l'affichage TRC tout entier. Le bouton SET permet de faire coïncider ces balayages, et ce afin d'obtenir ΔT exact sur l'affichage LED.

A noter que pour commander le temps DELAY seul le bouton DELAY doit être enfoncé.

ΔT peut être actionné si le bouton ΔT a été enfoncé.

La valeur maximale du temps DELAY et du temps ΔT est égale au temps de balayage total de BTP.

Lors de la commande du temps en mode ΔT , la somme des temps DELAY et ΔT peuvent excéder le temps de balayage de BTP.

Cependant, le marqueur ΔT ne disparaît pas de l'affichage TRC, mais s'arrête à la fin du balayage de BTP.

Le temps ΔT reste stocké dans une mémoire interne de sorte que, si le temps DELAY décroît, le marqueur ΔT commence à dévier à un certain moment.

LED DIV

Lorsque le vernier MAIN TB n'est pas en position CAL, l'affichage LED ne peut indiquer le temps ΔT ; cependant, le temps ΔT est indiqué en nombre de divisions sur l'affichage.

Dans ce cas, le témoin "DIV" est allumé et "S or Hz" éteint.

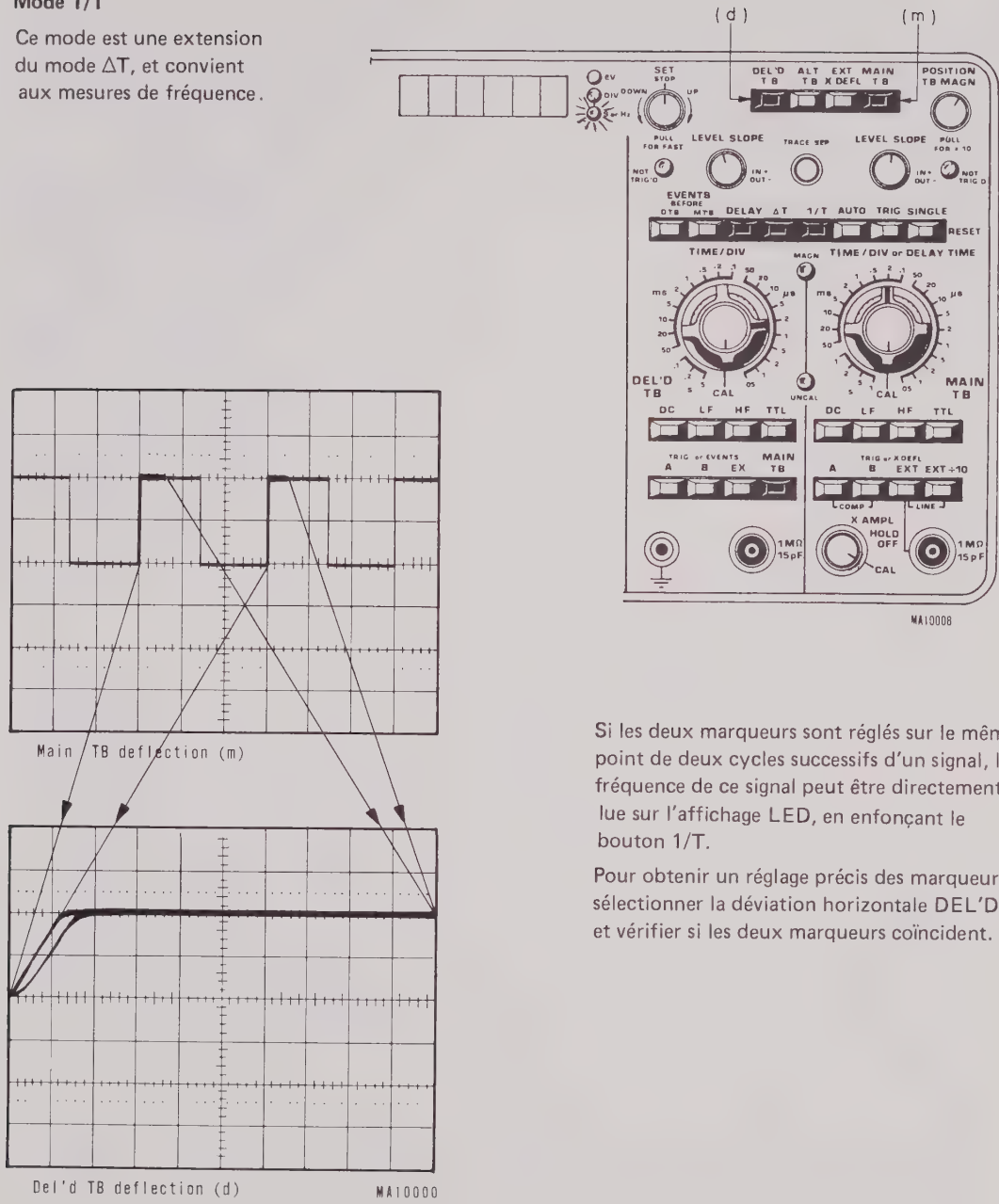
TB MAGN

Si TB MAGN est actionné, l'affichage LED n'est pas modifié et reste donc en affichage x1.

^{*)} En fait le balayage de base de temps retardée DELAY est écrit sur un balayage de base de temps principale et le balayage BTR DELAY et ΔT sur le balayage BTP suivant, et ainsi de suite.

3.7.3. Mode 1/T

Ce mode est une extension du mode ΔT , et convient aux mesures de fréquence.

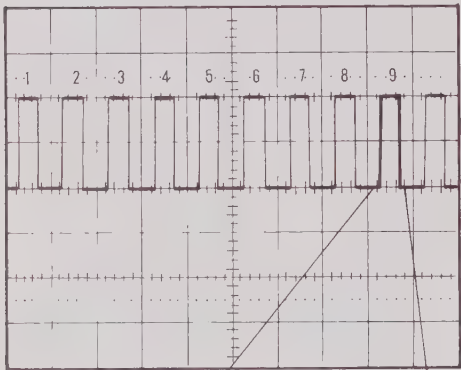


Si les deux marqueurs sont réglés sur le même point de deux cycles successifs d'un signal, la fréquence de ce signal peut être directement lue sur l'affichage LED, en enfonçant le bouton 1/T.

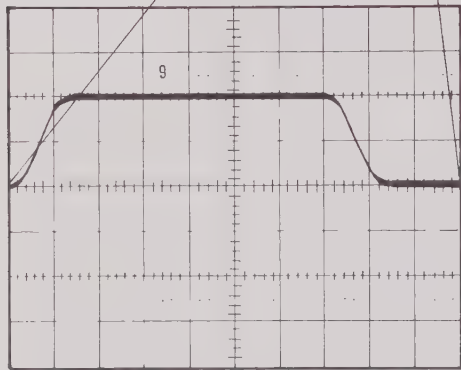
Pour obtenir un réglage précis des marqueurs, sélectionner la déviation horizontale DEL'D TB et vérifier si les deux marqueurs coïncident.

3.7.4. EVENTS BEFORE DTB (événements avant BTR)

Dans ce mode, la base de temps retardée est déclenché après comptage d'un nombre pré-sélectionné d'événements (impulsions). La base de temps retardée doit être déclenché à partir de A, B ou EXT. Le nombre d'événements à compter est lu sur l'affichage LED et peut être commandé à l'aide du bouton SET. Le nombre maxi d'événements à compter est de 99999.

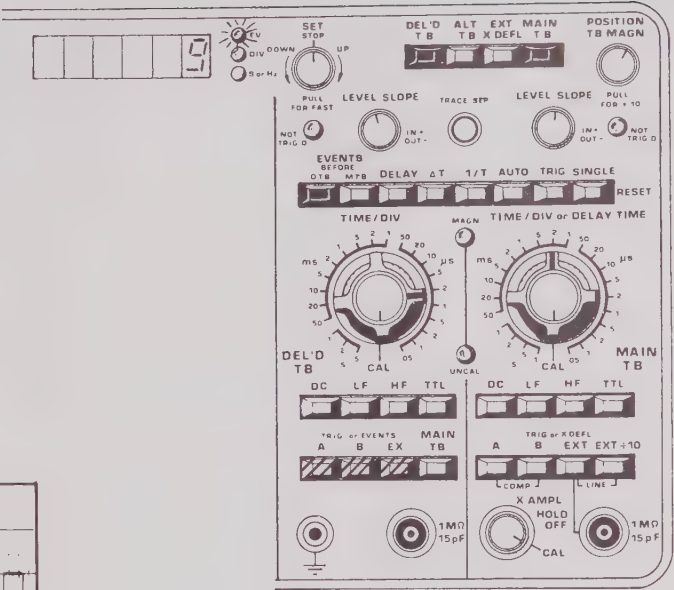


Main TB deflection (a)



Del'd TB deflection (d)

MA10001



MA10009

A noter que, si le bouton MAIN TB du sélecteur de déclenchement BTR est enfoncé, le message "erreur" est lu sur l'affichage LED (parce que dans ce cas il n'y a pas des signaux trigger).

Le compte d'événement commence à compter au point de départ du balayage BTP. Si le témoin NOT TRIG'D (BTR) reste allumée, il se peut qu'un nombre supérieur d'événements au nombre disponible pendant un balayage BTP soit affiché, ou le réglage Trigger n'est pas bien ajusté.

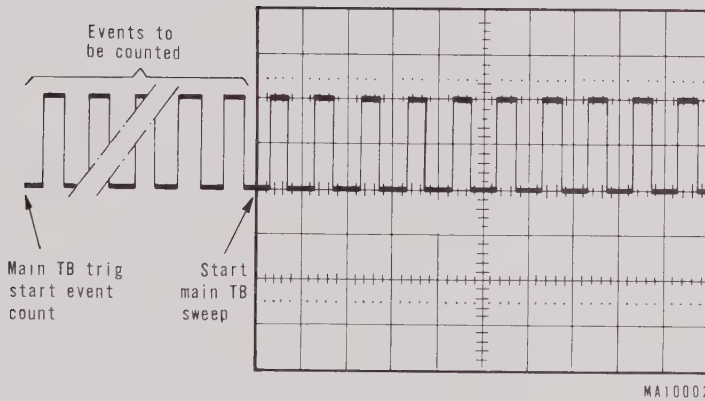
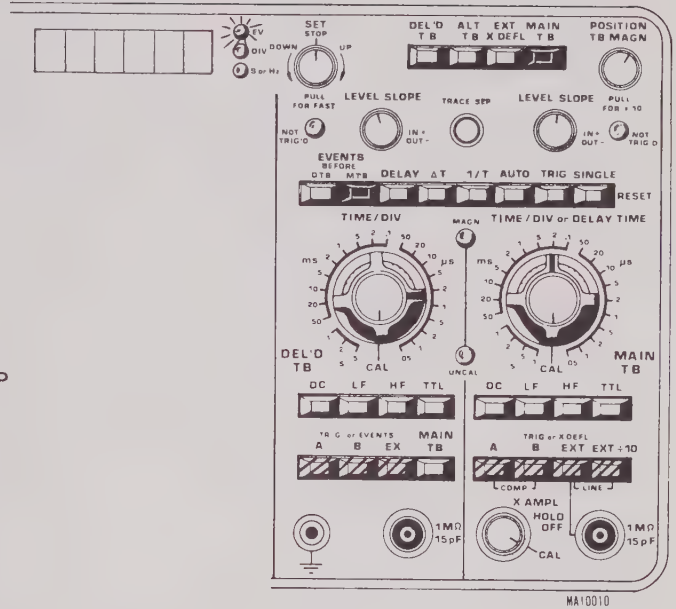
3.7.5. EVENTS BEFORE MTB (événements avant BTP)

Dans ce mode, la base de temps principale est déclenchée après comptage d'un nombre présélectionné d'événements (impulsions) présents dans le circuit de déclenchement BTR (A, B ou EXT).

Le nombre d'événements à compter est lu sur l'affichage LED et peut être commandé à l'aide du bouton SET.

Le nombre maxi d'événements à compter est de 99999.

Le compteur d'événements commence à compter à la réception d'une impulsion de déclenchement BTP; de plus, le circuit BTP doit être déclenché par A, B ou EXT.

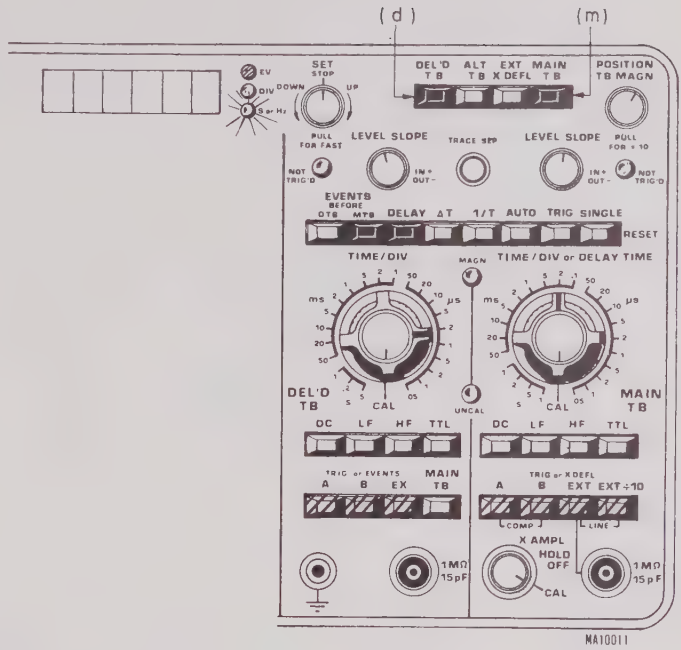
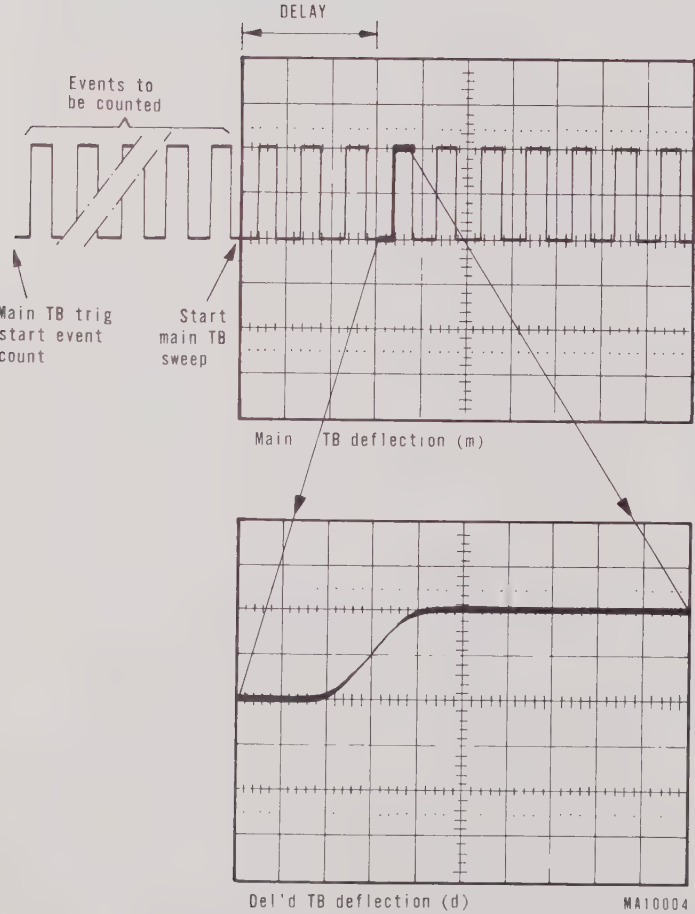


Pour une compréhension plus aisée, les événements à compter sont représentés à gauche sur l'affichage TRC.

Le mode EVENTS BEFORE MTB convient en combinaison avec les modes DELAY et ΔT .

3.7.6. EVENTS BEFORE MTB et DELAY (événements avant BTP et retard)

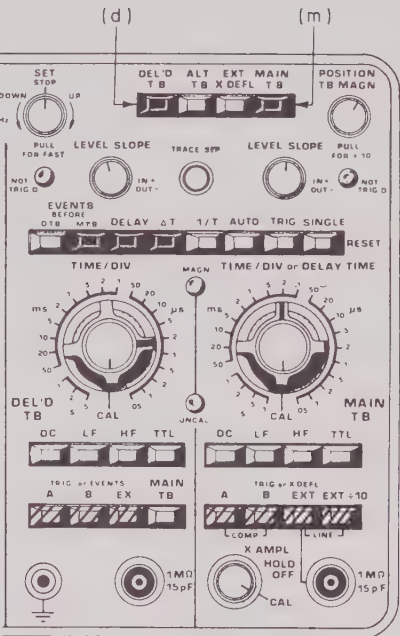
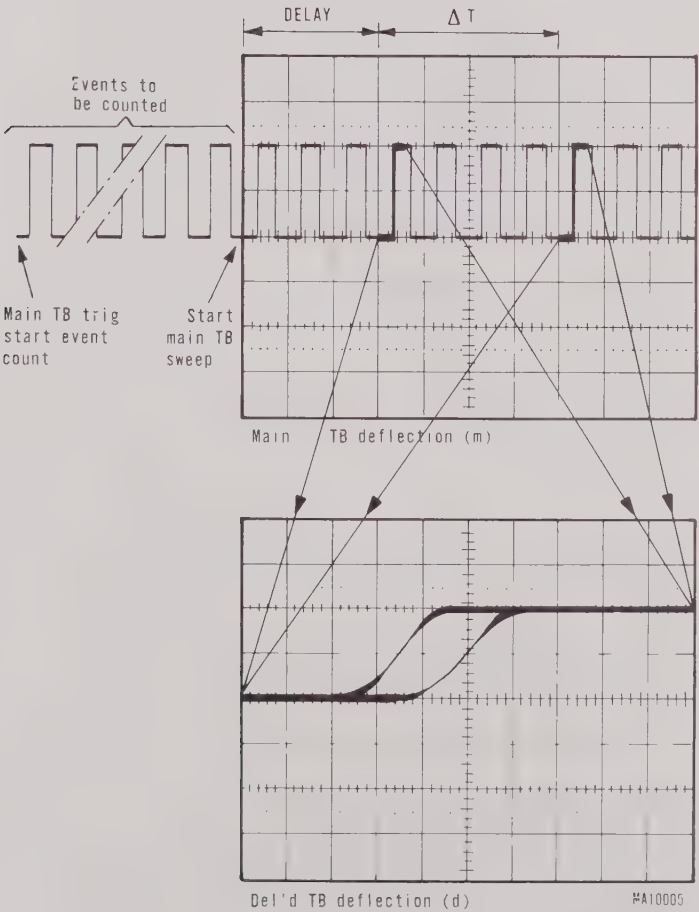
Il s'agit d'une extension du mode précédent.
La BTP déclenche après comptage d'un nombre présélectionné d'événements (impulsions) présents dans le circuit de déclenchement BTR (A, B ou EXT).
Enfoncer d'abord le bouton EVENTS BEFORE MTB et sélectionner le nombre d'événements à compter.



Enfoncer alors DELAY et sélectionner le temps de retard.

3.7.7. Events before MTB et DELAY et ΔT (événements avec BTP et retard et ΔT)

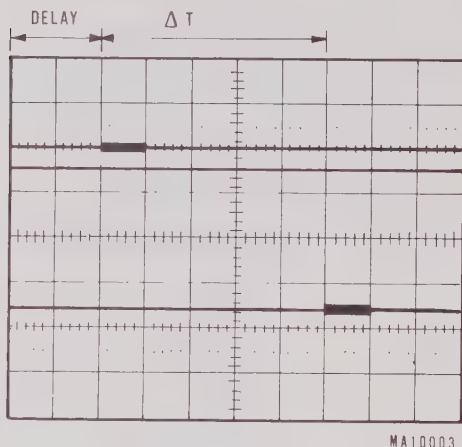
Il s'agit d'une extension du mode EVENTS BEFORE MTB. Les deux balayages BTR peuvent servir de marqueurs; ΔT est l'intervalle de temps entre les marqueurs. La base de temps principale déclenche après comptage d'un nombre présélectionné d'événements présents dans le circuit de déclenchement BTR (A, B ou EXT). Enfoncer d'abord le bouton EVENTS BEFORE MTB et sélectionner le nombre d'événements à compter.



Ensuite, enfoncer DELAY et sélectionner le temps de retard (position du premier marqueur). Enfoncer également ΔT et sélectionner le temps d'intervalle (position du second marqueur). Pour le réglage précis du marqueur, sélectionner la déviation horizontale DEL'D TB et vérifier si les deux marqueurs coïncident. Le mode 1/T peut être sélectionné lorsque les deux marqueurs sont situés en un même point des deux cycles successifs.

3.7.8. Delay et ΔT combinée à l'affichage alterné vertical

Si ce mode est sélectionné, la trace A indique seulement le premier balayage de la base de temps retardée et la trace B seulement le second.



Il s'agit là d'un mode utile à la mesure du temps entre deux différentes parties de deux signaux. Les deux signaux doivent être en rapport de temps (par ex. synchronisés par la même impulsion d'horloge).

Connecter un signal à l'entrée de voie A et l'autre à l'entrée de voie B.

La source de déclenchement de la base de temps principale peut être A, B ou EXT.

Sélectionner les deux parties du signal en réglant les temps DELAY et DELAY et ΔT .

Le temps entre les points de départ des deux sections de trace intensifiées est lu sur l'affichage LED.

Pour réglage précis, sélectionner la déviation horizontale DEL'D TB.

3.7.9. Affichage LED avec commande SET

Cet affichage comporte 6 digits. Il est allumé lorsque:

1. EVENTS BEFORE MTB est sélectionné

ou

2. DTB TIME/DIV n'est plus en position OFF

et

EVENTS BEFORE DTB
ou DELAY
ou ΔT } est sélectionné

Indépendamment des conditions précédentes, l'affichage est allumé:

- pendant le test de mise en service, au moment où l'oscilloscope est mis en service
- en mode auto-test (voir section "Service" de la présente notice).

L'affichage LED indique:

- Un nombre d'événements (impulsions) en mode EVENTS BEFORE DTB ou MTB; le témoin EV est allumé. Le bouton SET permet de sélectionner tout nombre entre 1 et 99999.
- Une durée de temps en mode DELAY ou ΔT . Le temps est indiqué comme mantisse avec exposant de dix. Le temps maximale indiqué sur l'affichage LED est égal au temps de balayage de la base de temps principale.
- Une fréquence en mode 1/T. Indiqué comme mantisse avec exposant de dix.

Autres possibilités d'affichage:

— *TB OFF*

Indique que, pour déviation horizontale, EXT X DEFL a été sélectionné.

— *ERROR*

Indique que, en mode EVENTS, la source de déclenchement MAIN TB en fonction DEL'D TB a été sélectionné. Enfoncer A, B ou EXT du déclenchement BTR.

— *UNCAL*

L'affichage peut indiquer le mot UNCAL ainsi que le chiffre 1, 2 ou 3.

L'affichage UNCAL sert à faciliter la tâche de l'opérateur, lui indiquant qu'un mesurage calibré n'est pas possible dans ce cas.

UNCAL 1 Signifie que, en mode DELAY ou ΔT , la source A, B ou EXT a été choisie pour le déclenchement BTR.

Enfoncer le bouton MAIN TB en fonction DEL'D TB.

UNCAL 2 Signifie que, en mode 1/T; la distance entre les marqueurs est inférieure à 0,1 DIV; la valeur affichée n'est dès lors plus exacte. Choisir alors un balayage BTP plus court ou augmenter le temps à l'aide du bouton SET.

UNCAL 3 Indique que, en mode 1/T, le vernier de balayage BTP n'est pas en position CAL.

— *Témoin EV*

Est allumé lorsque l'affichage indique un nombre d'événements à compter.

— *Témoin DIV*

Est allumé lorsque, en mode DELAY ou ΔT , le bouton de balayage MAIN TB n'est pas en position CAL.

Dès lors, l'affichage LED n'indique plus en temps, mais un nombre de divisions TRC.

Le témoin S or Hz est alors éteint.

— *Témoin S or Hz*

Est allumé en mode DELAY, ΔT ou 1/T.

— *SET*

Ce bouton permet de commander le(s) temps de retard en mode DELAY TIME ou ΔT , et le nombre d'événements à compter en modes EVENTS BEFORE DTB ou BEFORE MTB.

Toute manipulation de ce bouton influence directement l'information lue sur l'affichage LED.

En position centrale (STOP) de ce bouton, l'information sur LED reste inchangée. Cette valeur croît ou décroît en tournant le bouton respectivement vers la droite et vers la gauche. Au plus l'écart en fonction de la position centrale, au plus élevé est le changement sur LED. Ce taux augmente d'un facteur 100 en enfonçant le bouton SET.

4. CONTROLE DE FONCTIONNEMENT

4.1. GENERALITES

Ce contrôle permet de vérifier les fonctions principales de l'oscilloscope d'une manière nécessitant un minimum d'étapes et d'actions de contrôle. On suppose que l'opérateur chargé de ce contrôle connaît l'oscilloscope et ses caractéristiques.

ATTENTION: avant de le mettre sous tension, vérifier que l'oscilloscope a été installé conformément aux indications figurant dans le chapitre 2.

Si l'on commence ce contrôle quelques minutes après la mise sous tension, il faut tenir compte du fait que les étapes du contrôle risquent d'être faussées, en raison d'un temps de chauffage insuffisant. Pour éviter un tel risque, attendre que le temps de chauffage indiqué soit écoulé. Le contrôle devrait être effectué sous une température ambiante de 20 - 30°C. Les valeurs des mesures à effectuer sont indiquées sans tolérances et représentent les caractéristiques d'un appareil moyen; pour les tolérances se reporter au chapitre 1.2 "Caractéristiques". Les contrôles sont effectués à l'aide du générateur de tension de calibration interne de l'appareil.

4.2. POSITION DE DEPART DES COMMANDES

Mettre l'appareil sous tension et vérifier l'affichage LED pour voir si le micro-ordinateur effectue le contrôle sous tension: le signe  apparaît de gauche à droite sur chaque chiffre pendant 0,5 sec. Après quoi, les diodes électroluminescentes EV, DIV et S s'allument pendant 0,5 sec.

- Enfoncer le bouton-poussoir AUTO du sélecteur de mode de déclenchement S8,
- Enfoncer le bouton-poussoir ALT du sélecteur de mode d'affichage vertical S1,
- Mettre les commutateurs AMPL/DIV S9 et S11 des voies A et B sur les positions 0,5V/DIV et leurs verniers R8/S10 et R9/S12 sur la position CAL,
- Mettre les commandes POSITION R3/S4 et R4/S5 des voies A et B sur leurs positions médianes et appuyer,
- Mettre les commandes de couplage S17 et S18 des signaux AC/O/DC des voies A et B sur la position 0,
- Mettre le commutateur TIME/DIV S15 de la base de temps principale sur la position 0,1ms/DIV et sa commande vernier R11/S16 sur la position CAL,
- Mettre la commande TIME/DIV S13 de la base de temps retardée sur la position OFF et sa commande vernier R10/S14 sur la position CAL,
- Enfoncer le bouton-poussoir MAIN TB du sélecteur de mode d'affichage horizontal S2,
- Mettre la commande de POSITION horizontale R2 sur sa position médiane et appuyer,
- Enfoncer les boutons-poussoirs DC des commutateurs de couplage de déclenchement MAIN TB et DEL'D TB S19 et S20,
- Les boutons-poussoirs non mentionnés doivent être libérés.

4.3. SECTION D'AFFICHAGE SUR TUBE CATHODIQUE

- Régler les commandes INTENS et FOCUS R16 et R17 pour obtenir un affichage bien défini. Lors des contrôles, il pourrait s'avérer nécessaire de régler à nouveau les commandes,
- Centrer les lignes des bases de temps des voies A et B en utilisant les potentiomètres POSITION R3, R4 et R2,
- Vérifier que les lignes des bases de temps s'étendent exactement en parallèle avec les lignes horizontales du réticule. Si ce n'est pas le cas, régler la commande de rotation de trace (TRACE ROTATION) R15. Il s'agit d'une commande, située sur le panneau frontal, actionnée par tourne-vis.

4.4. VOIES VERTICALES

- Le contrôle des voies A et B est identique. Les boutons, douilles et organes de réglage de la voie B sont indiqués entre parenthèses après ceux de la voie A,
- Mettre le commutateur TIME/DIV de la base de temps principale sur la position 50ms/DIV et vérifier que la voie A et la voie B sont affichées en alternance,
- Enfoncer le bouton-poussoir CHOP du sélecteur de mode d'affichage vertical et vérifier que la voie A et la voie B semblent être affichées simultanément,
- Mettre le commutateur TIME/DIV de la base de temps principale sur la position 0,1ms/DIV,
- Enfoncer le bouton-poussoir A (B) du sélecteur de mode d'affichage vertical: seule la ligne de base de temps de la voie A (B) est visible,
- Enfoncer la bouton-poussoir A (B) du sélecteur de la source de déclenchement de la base de temps principale S22,
- Appliquer la tension de sortie de la douille CAL X1/X2 sur la douille d'entrée X3 (X4) de la voie A (B),
- Mettre le commutateur de couplage des signaux de la voie A (B) sur la position DC; le signal de sortie de la douille CAL est alors visible sur l'écran,
- Régler le niveau (LEVEL) de la base de temps principale pour qu'une forme d'onde stable soit inscrite. La déflexion verticale doit être de six divisions. Dans le cas contraire, ajuster, à l'aide d'un tourne-vis, le point de réglage R12 (R13) du panneau frontal,
- Vérifier également la sélection S7 de la pente (SLOPE) de déclenchement qui est incorporée à la commande de niveau (LEVEL) R7. Si on tire sur la commande R7/S7, la trace démarre sur la pente allant en sens négatif du signal et si on appuie sur cette commande, la trace démarre sur la pente allant en sens positif du signal
- Le signal qui est affiché est une onde carrée ayant un niveau inférieur de 0V et un niveau supérieur de 3V,
- Le signal contient une composante continue de 1,5V. Si le commutateur de couplage AC/O/DC est sur la position AC, la composante continue est bloquée et le signal se trouve alors symétrique autour du niveau 0V sur l'écran. Vérifier ensuite la position AC,
- Vérifier que le signal de la voie A (B) sur l'écran est renversé si la fonction PULL TO INVERT est mise en circuit en tirant sur la commande de POSITION A (B) S4/R3 (S5/R4),
- Appuyer à nouveau sur la commande POSITION de la voie A (B),
- Enfoncer le bouton-poussoir EXT X DEFL du sélecteur de mode de déflexion horizontale S2,
- Enfoncer le bouton-poussoir A (B) du sélecteur de source de déclenchement de la base de temps principale S21,
- Appliquer la tension de sortie de la douille CAL sur la douille d'entrée de la voie A (B),
- Enfoncer le bouton-poussoir B (A) du sélecteur de mode de déflexion verticale S1,
- Vérifier que deux points sont affichés espacés d'une distance horizontale de six divisions,
- Enfoncer le bouton-poussoir TRIG VIEW du sélecteur de mode de déflexion verticale,
- Enfoncer le bouton-poussoir A (B) du sélecteur de la source de déclenchement de la base de temps principale,
- Appliquer la tension de sortie de la douille CAL sur la douille d'entrée de la voie A (B),
- Enfoncer le bouton-poussoir MAIN TB du sélecteur de mode de déflexion horizontale S2,
- Vérifier qu'un signal en creneaux de six divisions est affiché sur l'écran. Ce signal est décalé dans un sens vertical si l'on agit sur la commande de niveau (LEVEL) de la base de temps principale.

4.5. BASES DE TEMPS ET DECLENCHEMENT

- Enfoncer le bouton-poussoir A (B) du sélecteur de mode d'affichage vertical S1,
- Appliquer le signal de sortie de la douille CAL sur la douille d'entrée de la voie A (B),
- Enfoncer le bouton-poussoir A (B) du sélecteur de source de déclenchement de la base de temps principale S22,
- Mettre le commutateur TIME/DIV de la base de temps principale sur la position 0,1ms/DIV,
- Enfoncer le bouton-poussoir MAIN TB du sélecteur de mode d'affichage horizontal S2,
- Régler la commande de niveau (LEVEL) R7 de la base de temps principale pour obtenir un affichage déclenché,
- Tirer sur la bouton TB MAGN R2/S3 qui est incorporé à la commande de POSITION horizontale et vérifier que la déflexion horizontale est amplifiée d'un facteur de dix fois,
- Enfoncer à nouveau le bouton TB MAGN,
- Enfoncer le bouton-poussoir SINGLE du sélecteur de mode de déclenchement S8. Vérifier que la base de temps principale ne fonctionne qu'une seule fois après avoir lâché ce bouton,
- Enfoncer à nouveau le bouton-poussoir AUTO du sélecteur de mode de déclenchement,
- Mettre la commande TIME/DIV S13 de la base de temps retardée sur la position 20 μ s/DIV et son vernier R10/S14 sur la position CAL,
- Enfoncer le bouton-poussoir MAIN TB du sélecteur de source de déclenchement de la base de temps retardée S21,
- Enfoncer le bouton-poussoir de retard (DELAY) S26,
- Déplacer la commande SET (R1/S24) de la position d'arrêt (STOP) vers la position de comptage (UP),
- Vérifier que la partie intensifiée du balayage de la base de temps retardée se déplace vers la droite sur l'affichage de la base de temps principale. Le nombre affiché sur l'affichage LED doit alors augmenter,
- Mettre la commande SET sur la position de décomptage (DOWN),
- Vérifier que la partie intensifiée du balayage de la base de temps retardée se déplace vers la gauche sur l'affichage de la base de temps principale. Le nombre affiché sur l'affichage doit alors diminuer,
- Vérifier, pour quelques points sur l'affichage de la base de temps principale, que le retard indiqué sur l'écran du tube cathodique est correct par rapport au temps de retard indiqué sur l'affichage LED,
- Vérifier que, la commande vernier TIME/DIV de la base de temps principale étant sur la position UNCAL, l'affichage indique le retard en divisions (DIV) et non en secondes,
- Mettre à nouveau la commande TIME/DIV de la base de temps principale sur la position calibrée CAL,
- Enfoncer le bouton-poussoir DEL'D TB du sélecteur de mode d'affichage horizontal S2. Vérifier que la partie intensifiée recouvre alors toute la largeur horizontale de l'écran,
- Enfoncer le bouton-poussoir ALT TB du sélecteur de mode d'affichage horizontal. Le signal de la base de temps principale et la partie intensifiée sur toute la largeur horizontale de l'écran doivent être, tous les deux, affichés. Le décalage vertical entre les deux affichages doit être réglable à l'aide de la commande de séparation de traces R6,
- Enfoncer le bouton-poussoir MAIN TB du sélecteur de mode d'affichage horizontal S2,
- Régler le retard à l'aide de la commande SET pour que le démarrage de la partie intensifiée coïncide avec la première pente allant en sens négatif sur l'écran,
- Enfoncer le bouton-poussoir ΔT (S27) et positionner, à l'aide de la commande SET, une seconde partie intensifiée pour qu'elle coïncide avec la seconde pente allant en sens négatif sur l'écran,
- L'affichage doit afficher alors la différence de temps ΔT entre le démarrage des deux parties intensifiées: cette valeur ΔT doit être d'environ 0,5ms,
- Enfoncer le bouton-poussoir 1/T (S28) et vérifier que l'affichage affiche alors la fréquence de l'onde carrée sur l'écran. Cette fréquence doit être d'environ 2kHz,
- Lâcher les boutons-poussoirs DELAY, ΔT et 1/T,
- Enfoncer le bouton-poussoir A (B) du sélecteur de source de déclenchement de la base de temps retardée S21,
- Mettre le commutateur TIME/DIV de la base de temps principale sur la position 0,2ms/DIV,
- Enfoncer le bouton-poussoir EVENTS BEFORE DTB (S25),
- Ajuster le nombre d'événements sur l'affichage à 4 (3, 2, 1),
- Régler la commande (R5/S6) de niveau/pente (LEVEL/SLOPE) de la base de temps retardée pour obtenir une partie intensifiée qui démarre sur la 4e (3e, 2e, 1ère) pente allant en sens positif du signal sur l'écran,
- Vérifier que, si l'on tire sur la commande de niveau/pente (LEVEL/SLOPE) (R5/S6) de la base de temps retardée, la partie intensifiée démarre sur la 4e (3e, 2e, 1ère) pente allant en sens négatif du signal sur l'écran,
- Enfoncer à nouveau la commande de niveau/pente (LEVEL/SLOPE) de la base de temps retardée,
- Mettre la commande TIME/DIV de la base de temps retardée sur la position arrêt (OFF),
- Enfoncer le bouton-poussoir EVENTS BEFORE MTB (S25),

- Ajuster le nombre d'événements (EV), indiqué sur l'affichage, à 4,
- Vérifier qu'il est possible de régler la commande de niveau/pente (LEVEL/SLOPE) (R5/S6) de la base de temps retardée pour obtenir un affichage déclenché. Pour effectuer ce contrôle il est nécessaire que la commande de niveau/pente (LEVEL/SLOPE) (R7/S7) de la base de temps principale occupe la position déclenchée. Par conséquent l'indicateur NOT TRIG'D de la base de temps principale doit être coupé.

5. ENTRETIEN PREVENTIF

5.1. GENERALITES

Le présent appareil ne requiert en principe aucune maintenance, car il ne contient pas de composants sujets à l'usure. Cependant, pour garantir le fonctionnement fiable et sans défaillances, l'appareil ne doit pas être exposé à l'humidité, le chaleur, des éléments corrosifs ou la poussière excessive.

5.2. NETTOYAGE DU REVETEMENT SUEDE NEXTEL

ATTENTION: Le revêtement suède NEXTEL résistance à l'éthanol, pas à l'alcool à brûler: la décomposition d'une des substances endommagerait le revêtement NEXTEL de façon irréparable.

Au bout d'un certain temps, le revêtement suède NEXTEL perd de son éclat. Un nettoyage régulier de la surface à l'aide d'un chiffon humide (eau, éthanol ou autre détergent) ne donnera pas le résultat escompté. La surface frottée par un chiffon sera nettoyée, non les granulations et les griffes.

3M-COMPANY a développé une nouvelle méthode de nettoyage permettant le nettoyage des granulations. L'éponge no. 8840 de 3M doit être trempée dans l'eau, l'éthanol ou un détergent courant. Il s'agit d'un chiffon ayant les mêmes propriétés que les éponges ou les chiffons abrasifs: il nettoie les surfaces et leur redonne l'éclat sans toutefois les griffer.

5.3. RE-ETALONNAGE

La pratique a prouvé que l'oscilloscope fonctionne dans les limites spécifiés pendant une période de 1000 heures de travail ou de 6 mois en cas d'usage irrégulier.

De plus, le remplacement de composants peut nécessiter un ré-étalonnage des circuits affectés. Les procédés de contrôle et d'ajustage peuvent également servir à détecter certaines fautes dans l'appareil.

Dans certains cas, des troubles mineurs peuvent être localisés et/ou corrigés par le ré-étalonnage. Les instructions complètes de contrôle et d'ajustage sont mentionnées au chapitre "Contrôles et réglages".

Service manual

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6. CIRCUIT DESCRIPTION

6.1. DESCRIPTION OF THE BLOCK DIAGRAM (Refer to Fig. 6.1.)

6.1.1. General information

The PM 3263 oscilloscope comprises the following parts:

- a dual-channel vertical system
- a main time-base
- a dual-delayed time-base
- an event trigger-mode stage
- a display-mode logic stage
- an X amplifier
- a Z-stage
- a .c.r.t. circuit
- a micro-processor circuit
- a stabilized power supply.

6.1.2. Dual-channel vertical system

Both vertical channels (YA and YB) contain identical circuits. An input to one of the channels is applied, via a coupling switch AC/0/DC to the input attenuator. In the AC position of the coupling switch there is a capacitor in the signal path. In the DC position the coupling is direct.

If the coupling switch is set to the 0 position, the connection between the input socket (X3-Y_A, X4-Y_B) and the attenuator input is interrupted, the latter being earthed.

The input attenuator, which is controlled by the AMPL/DIV switch, enables the adjustment of the vertical-deflection sensitivity in calibrated steps.

The attenuator is followed by a low-drift impedance converter with drift compensation which gives the input circuit a high input impedance.

The impedance converter also contains a voltage divider, which works in conjunction with the input attenuator.

The signal that leaves the impedance converter is applied to a balance amplifier (D201-Y_A, D301-Y_B) where it is transformed into a push-pull signal. The balanced amplifier has two outputs. From one of these outputs the signals are applied to a trigger selector stage and from the other one to an amplifier stage (D202-Y_A, D302-Y_B).

This stage comprises the switch NORMAL/INVERT by means of which the phase of each signal can be inverted, and the controls for vertical positioning.

The following stage is a channel selector which either blocks or passes the signal as dictated by the vertical display-mode logic and switches.

In the A, B, ADD and TRIG VIEW modes the channel selector is set by means of voltage levels (via the display-mode logic stage) and in the ALT and CHOP mode controlled by pulses (also via the display-mode logic stage). In the ALT mode those pulses are supplied by the sweep-gating multivibrator of the main time-base generator during the flyback of the sweep, so that alternately the complete signals of channel A, channel B and the 3rd channel TRIG VIEW are displayed.

In the CHOP mode the drive pulses with a fixed frequency of approximately 1 MHz are derived from the clock-signal of the micro-processor.

Those pulses cause the electronic switches in the display-mode logic stage to be successively opened and closed, so that successively part of the signal of channel A, channel B and the 3rd channel TRIG VIEW are displayed.

After the channel selector, the following circuits are common to the vertical channels:

A delay line driver stage, a delay line that delays the vertical signals to such an extent that the steep leading edges of fast signals are still displayed and a final Y-output stage, which feeds the signals to the vertical-deflection plates.

6.1.3. Time bases

Main time-base

The M.T.B. trigger and X-deflection amplifier (V803, V804, V806) receives its signal, via pre-amplifiers, from one of the vertical channels or both (COMPOSITE), from the attenuator/impedance converter for external trigger or X-deflection signals, or from the power supply (LINE). One of those signals can be selected by operating one of the controls incorporated in this stage (i.e. EXT, EXT/10, LINE, A, B, COMP.).

From this stage the signal is fed to either the X-deflection amplifier for horizontal deflection, or the sweep-gating logic for starting the time-base generator. The output used to feed the sweep-gating logic is also fed to the event counter to start the count when the event counter triggering is used for the main time-base.

The M.T.B. trigger amplifier (including D802) is a differential one, containing the controls for trigger-level adjustment, slope selection, and coupling (i.e. DC/LF/HF and TTL) selection.

The slope selector allows the polarity of the trigger signal to be inverted, enabling triggering on the positive as well as the negative slope of the input signals.

The sweep-gating logic starts and stops the time-base generator, which delivers the sawtooth signal required for normal time-base operation.

The generator comprises the charging capacitors and current source-resistors selected by the TIME/DIV switch in order to set the time coefficients in calibrated steps. Continuous control of the time coefficients is obtained by varying the charging current of the time-determining capacitors by means of the TIME/DIV continuous potentiometer; in this case, the UNCAL lamp is on.

The amplified output signal of the time-base generator is fed to the X-deflection selector, the comparator (which is a part of the delayed time-base unit) and (via a feedback loop) to the hold-off circuit. The hold-off circuit resets the sweep-gating flip-flop (D901) and blocks its input during the flyback of the sawtooth signal. The hold-off circuit also incorporates the single-sweep circuit.

The three modes of operation of the main time-base are determined by the three-position switch AUTO/TRIGG, SINGLE.

In the AUTO mode, the automatic free-run circuit is operative when triggering pulses are absent. Thus a trace, though not necessarily a stationary one, is always displayed even though the trigger controls may not be correctly adjusted. In this way, correct adjustment of the oscilloscope trace is greatly facilitated. However, when trigger pulses are present the circuit reverts to the normal triggered mode. If trigger pulses disappear, the time-base free-runs after a lapse of approx. 100 ms. In the TRIGG mode, a display is present only when suitable trigger pulses are available.

In the SINGLE mode, events that occur only once can be observed and photographed if necessary. It is often desirable to ensure that only one sweep is generated, even though other trigger pulses might follow the phenomenon of interest. In this mode, after the trigger pulse has initiated the main time-base to produce one sweep, the circuit is unaffected by further trigger pulses until it is manually reset for the next event by operating the reset pushbutton.

Dual-delayed time-base

The delayed trigger-circuit and delayed time-base generator are in principle, similar to the main trigger-circuit and the main time-base generator. The delayed time-base works in the single or dual operation mode. It is started by the main time-base generator, which also serves as hold-off circuit for the delayed time-base.

For time, events or frequency measurements in complex signals the dual-delay facility is used. In the PM 3263, the usual delay time multiplier control potentiometer is superseded by the SET potentiometer which controls oscillator (VCO). The number of pulses selected is stored in the memory of the microprocessor (μ P) and transferred to the LED display. By means of digital counters in the dual DAC, two d.c. voltages are produced by pulse-width modulation that correspond to the delay and ΔT times. These two d.c. voltages are alternately switched to the comparator D1303 for display on alternate main time-base sweeps. The ΔT is the elapsed time between the starting points of the two delayed time-bases.

The 1/T mode is an extension of the ΔT mode and enables if $\Delta T = 1$ cycle, a frequency indication of the displayed signal on the LED display. (The S or Hz lamp will be lit in the delay, ΔT or 1/T modes.

With the MTB TIME/DIV knob out of the CAL position the delay and/or ΔT times are indicated in divisions (the lamp DIV is on).

When pushbutton MAIN TB of the horizontal deflection mode controls has been depressed, the part of the trace coinciding with the delayed sweep is intensified, except in the OFF position of the delayed TIME/DIV switch.

Event trigger-mode stage

Triggering after pre-selecting a number of events is possible for both the main time-base and the delayed time-base. By means of the SET control the number of required pulses (events) before triggering can be set between 0 and 99999 and can be stored in the event counter.

The event counter counts only the trigger pulses that are present in the delayed time-base trigger circuit, although counting is started by the MTB trigger pulse.

Selecting the number of events before triggering is internally achieved by putting the 9's complement into the counter. The event counter then counts up to 99998 whereupon it frees the trigger so that the next pulse triggers the time-base.

The EVENTS BEFORE DTB/MTB control pushbuttons determine which of the time-bases will be triggered after the number of events pre-selected and indicated in the LED display (the EV lamp will be lit in this condition).

6.1.4. X-Deflection selector

The X-deflection selector couples the external X-deflection signal, the output signal of the main time-base generator or the output signal of the delayed time-base generator via the X-final amplifier, to the horizontal-deflection plates. The X-final amplifier comprises the horizontal trace positioning and 10x magnification controls.

The ALT and CHOP mode stages supply blanking pulses to the Z-amplifier.

ALT pulses unblank the trace during the sweep of the main time-base and provide an extra bright-up pulse if the oscilloscope operates with a portion of the trace intensified. CHOP pulses suppress the trace during the switching from channel Y_A to channel Y_B and/or the 3rd channel TRIG VIEW.

6.1.5. Z-Amplifier and c.r.t. circuit

The Z-amplifier receives two input signals. One originates in the time-base generator and is, via the X-deflection selector and ALT mode circuit, applied to the Z-amplifier to unblank the trace during the sweep.

The other one is supplied by the chop-mode circuit to blank the trace during switching from channel to channel in the chopped mode. The INTENS potentiometer determines the amount of input current fed to the Z-amplifier.

At the output of this amplifier, the signal is split into two parts: an l.f. + d.c. part and an h.f. part. The h.f. part is fed direct to the Wehnelt cylinder of the c.r.t. The l.f. + d.c. part is modulated on to an oscillator signal and afterwards detected in a peak-detector. Both signal parts are combined again on the Wehnelt cylinder.

The focus voltage for the c.r.t. is derived from a grid driver stage. The output voltage of this stage is rectified and applied to the focussing anode.

The focussing voltage is controlled by the FOCUS potentiometer which is electronically coupled with the INTENS potentiometer. In this way, defocussing due to operation of the INTENS potentiometer is largely obviated.

The high voltage for the post-acceleration anode of the c.r.t. is supplied by a secondary high tension winding of the converter transformer whose voltage is rectified and multiplied by a factor of 9.

Furthermore, the c.r.t. circuit comprises preset potentiometers for trace rotation, astigmatism, distortion and orthogonality.

6.1.6. Stabilized power supply

The mains voltage is full-wave rectified and fed to a regulated sine converter. The output voltage of the sine converter is kept constant by regulating the duty cycle of the applied voltage. This output voltage is applied to the primary of a transformer, the secondary voltages of this transformer are full-wave rectified, smoothed and applied to the various circuits.

The voltages required for the microprocessor, the event counter (partly ECL), the LED display and so on are made by an additional unit which is supplied from the power supply unit.

The MAINS triggering signal is taken direct from the mains and is fed, via an opto-isolator, to the trigger circuit at a safe level.

The calibrator is a square-wave generator, which supplies an accurate voltage and current for calibration purposes.

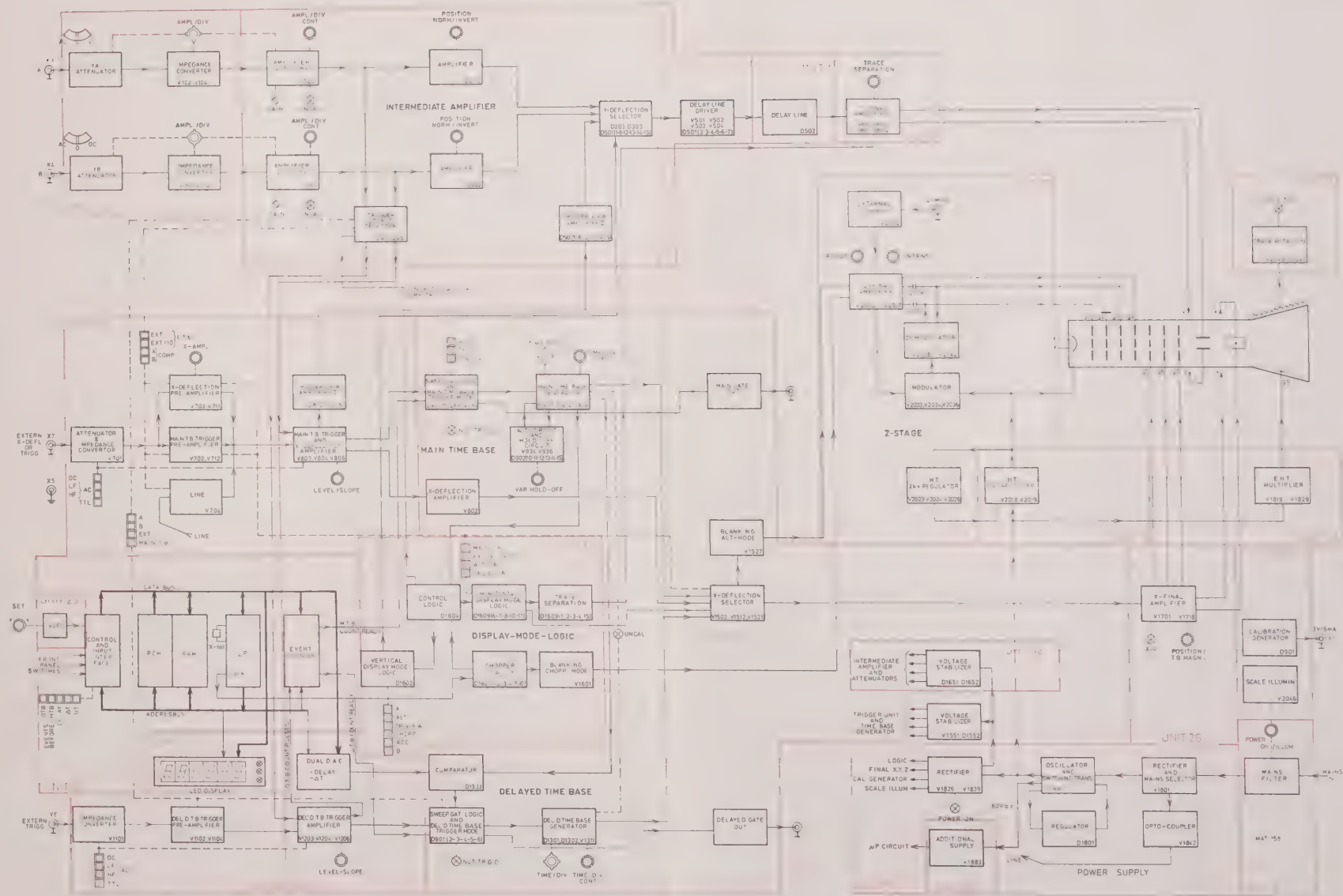


Fig. 6.1. Blockdiagram

6.2. CIRCUIT DESCRIPTION

6.2.1. Vertical deflection system

The oscilloscope contains three vertical channels, channels A and B and the TRIGger VIEW channel. The vertical channels A and B for the signals to be displayed are identical, each comprising an input coupling switch, an input step attenuator, an impedance converter and a preamplifier with trigger pick-off. A channel switch, controlled by the display mode pushbuttons, switches either channel A or channel B or the TRIGger VIEW channel to the final Y amplifier via the delay line driver and the delay line. The final Y amplifier feeds the Y deflection plates of the cathode-ray tube. The individual stages of the vertical deflection system are now described in some detail. As the channel paths for channel A and channel B are basically identical, only the channel A signal path is described.

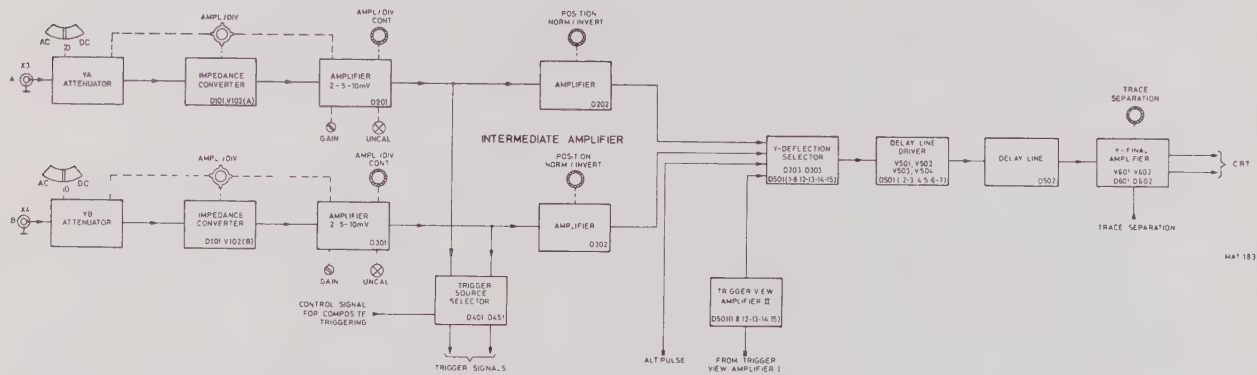


Fig. 6.2. Vertical deflection system

6.2.1.1. Input coupling

Input coupling switch S17 (AC-0-DC) forms a part of the input attenuator unit (Unit 2). Input signals connected to the A input socket X3 can be a.c. coupled, d.c. coupled or internally disconnected. In the AC position of S17, there is a capacitor (C102) in the signal path. This capacitor prevents the DC component of the input signal from being applied to the amplifier and reduces so the lower frequency limit to 10 Hz. In position DC of switch S17, the input signal is coupled directly to the step attenuator and at the same time, blocking capacitor C102 is discharged via R101, to prevent damage of the circuit under test by a possible high charge. Selection of the 0 position of S17 isolates the channel A input signal and earths the channel input for reference purposes; e.g. for calibration or centering the trace.

6.2.1.2. Input attenuator and impedance converter

The input stage comprises two identical attenuator circuits which are combined in one unit (unit 2). For convenience, only the channel A attenuator is described. The input attenuator consists of a triple high-ohmic voltage divider and an impedance converter in conjunction with a drift-correction circuit. The impedance converter provides an output at zero level, which can be adjusted by potentiometer R129, followed by a low-ohmic attenuator with attenuation factors of 1, 2 and 5. The overall attenuation of the input stage is determined by the combination of the selected sections of two voltage dividers. The various combinations are selected by the eleven positions of the front panel AMPL/DIV attenuator switch S9. The high-ohmic voltage divider sections attenuate by a factor of X1, X10 and X100. The low-ohmic divider D102 following the impedance converter, V102, V103, V104 gives attenuations of X1, X2 and X5 at the output. With the overall combinations of attenuation, eleven Y deflection coefficients are realised from 2 mV/DIV to 5 V/DIV in a 1-2-5 sequence. Only for the most sensitive positions 2 mV/DIV and 5 mV/DIV of the AMPL/DIV switch S9, the gain of the intermediate amplifier is increased.

Constant input capacitance for the various attenuator positions is achieved by trimmers C101, C104 and C109. The high-ohmic voltage divider sections are made independent of the input frequency (i.e., the capacitive attenuation for a.c. signals is adjusted to the resistive attenuation for d.c. signals) by means of trimmers C107 and C112.

A diode clipper V101, in the gate circuit of FET-transistor V102 protects the input source follower of the impedance converter from excessive voltage swings.

The high frequency path of the input signal consists of capacitor C114 and FET-transistor V102 connected in a source-follower configuration. The low frequency path of the input signal consists of error amplifier D101, which samples the input and output signals of the impedance converter over a frequency range from d.c. to 1 kHz. The error amplifier generates a correction signal on pin 6 which is fed to the impedance converter to replace the missing low frequency components of the high frequency path.

The gain of the low frequency path is set by adjusting the resistor divider ratio from which the output is sampled. Preset R 132 (L.F. corr) is adjusted so that the ratio of the network R134/R132 is the same as the ratio of network R122/R123. The off-set voltage of the error amplifier is corrected by preset R124.

After low-ohmic attenuator switching, the output from the impedance converter provides a correct impedance match for the coaxial cable to the intermediate amplifier.

6.2.1.3. Intermediate amplifier

The intermediate amplifier comprises two main stages.

The first stage comprises the gain adjustments, vernier and continuous control, level shifting, and sensitivity for the 2 mV, 5 mV and 10 mV ranges.

The second stage comprises a series-shunt feedback amplifier circuit formed by D202 input transistors and transistors V502, V504 on the delay-line driver circuit. Interposed in this stage are the normal/invert, shift and electronic switch facilities.

Both stages have overall gains of approximately 3.

To improve temperature control and stability, the intermediate amplifier mainly comprises integrated circuits. The signal paths for channel A and channel B are identical in the input stages, consequently, only the channel A input circuit is described.

The Y signal from the channel A attenuator is applied to a coaxial input socket on the intermediate amplifier, to pin 3 of integrated circuit D201. The asymmetrical input is converted to a symmetrical output in a transistor balance amplifier.

Potentiometer R211 provides a continuous balance control to correct for line shift.

Four diode-connected transistors across the base circuits of the D201 cascode transistors provide control of attenuation by means of GAIN control R12 and CONT. control R8, which vary the dynamic resistance of the diodes. Control R12 gives 5 % loss of gain in the mid-position and 10 % loss of gain at minimum. Control R8 gives a 3 to 1 attenuation, which is sufficient to give the desired overlap between the input attenuator steps. When the currents through the diode bridge are equal, there is no gain and the transistors are cut off. When current flows in one diode and not in the other, the gain is maximum.

The cascode transistors V204 and V203 that follow integrated circuit D201 provide additional gain for the most sensitive ranges by the selection of load resistors. By switching this additional gain at intermediate amplifier level a reduction in noise is achieved.

The different loads of V203, V204 are selected by switching diodes under the control of the front-panel AMPL switch positions.

In the 10 mV-5 V positions the - 5.2 V supply from AMPL/DIV switch S9 contact 14 is applied to the junction of R241, stabistor V208 and diode V211. The stabistor V208 conducts and applies the negative potential via switching diode V206 to load resistors R233 and R237 of V204 and V203 respectively. Diode V211 also conducts and blocks V213, thus causing transistor V214 to switch off and disconnect the load resistors R236 and R239.

In the 5mV position, the - 5.2 V supply from AMPL/DIV switch S9 contact 20 is applied to the junction of R242, and diodes V209, V212. Diode V212 conducts and applies the negative potential via switching diodes V207 to the load resistors R234 in series with R233 and R238 in series with R237 of V204 and V203 respectively. Diode V212 also conducts and blocks V213, thus causing transistor V214 to switch off and disconnect the remaining load resistors. To compensate for the reduction of bandwidth in the 5mV position because of the higher value of the load resistor, an additional capacitor, C202, is switched into the emitter circuit via R212 and diodes V201 and V202.

In the 2mV position, transistor V214 conducts because of the 0V applied to its base via R243 and V213. The resulting negative potential on its collector is applied to the total load resistors R237, R238, R239 and R234, R233, R236 of V204 and V203 respectively. In this position, switching diodes V206 and V207 are blocked. The 2 mV position is an extra facility, the bandwidth being degraded to 35 MHz.

To compensate for any shift of the trace that may occur when switching between the 5 mV and 10 mV positions, preset R216 is provided. It permits the emitter current of V203 to be adjusted, as required.

Emitter potentials for V203 and V204 are routed via feed resistors R218 and R219 respectively. The RC networks R219, C212 and R222, C214 provide damping. Series RC networks R214, C208 and R208, C206 on points 1 and 8 of the cascode circuit of D201 prevent any tendency for parasitic oscillation.

The second stage of the intermediate amplifier is a voltage-to-current amplifier that incorporates the trigger pick-off point, the NORMAL/INVERT switching facility, and the channel selection switching. The stage basically comprises two integrated circuits D202 and D203.

Emitter points 4 and 5 (D202) of the input transistors provide the trigger pick-off points that are routed to resistors R421 and R422 on the trigger circuit. A number of RC networks across the common emitter circuit provide for bandwidth compensation over the frequency range. Preset components are R253, R254 R255, R257 and R244.

The NORMAL/INVERT function is performed by a diode-gate switching circuit under the control of the PULL TO INVERT switch S4. In the NORMAL position, i.e. S4 is open, transistor V216 conducts because of the negative base potential applied via R271. Point 11 of D202 is therefore at 0V and this is applied to the bases of two transistors, which conduct and pass the signal through D202 without inversion (points 1-14, 8-12). The negative potential via R269 is passed to point 9 of D202 on the appropriate side of the diode gate network. This negative potential is applied to block the bases of the other pair of transistors in the signal path.

In the INVERT position, i.e. S4 is closed, V216 is cut off because of the 0V potential applied via R271. Point 11 of D202 now becomes negative via R268 and this switches off the two transistors that were previously conducting. The signal path is now inverted through the integrated circuit (points 1-13, 8-15) by the 0V signal applied via S4, R267 to point 9 of D202.

Any trace shift due to inversion can be corrected by preset R259.

The output signals are fed to pins 1 and 8 of integrated circuit block D203, the emitters of the electronic switching transistors. Channel selection is by means of a network, controlled from the logic circuit.

Front-panel POSITION control R3 applies a variable potential to the base of one of the input transistors to provide a means of shifting the trace.

6.2.1.4. Trigger pick-off and trigger source selection

The symmetrical trigger inputs from the A channel intermediate amplifier (D202) are fed via resistors R421 and R422 to points 3 and 6 of D401.

The symmetrical trigger inputs from the B channel intermediate amplifier (D302) are fed via resistors R471 and R472 to points 3 and 6 of D451.

Diode switches are again employed for channel switching for triggering on channel A, channel B or for composite triggering.

The outputs are asymmetrical and are taken via coaxial sockets to the trigger amplifier of the Main and Delayed time-bases.

The operation of the two integrated circuits D401 and D451 is identical. Therefore, only the channel A circuit D401 is described.

Transistor V401 provides a constant current source for the trigger pick-off stage for channel A. The collector output (point 7) is resistor-coupled to the common emitters of the switching transistors to provide a high gain output on point 13 (MTB trigger output) and point 15 (DTB trigger output) when the appropriate triggering is selected. Switching is achieved by front-panel selection. When channel A (DTB) is selected, the +11.4 V from point 2 of S21-A (which blocks V403 in the channel A OFF position) is removed and V403 conducts the channel A trigger signal (D401/15) to the delayed time-base trigger amplifier. When channel A (MTB) is selected, the +11.4 V from point 1 of S22-A is removed and V404 conducts (V407 off) to pass the channel A trigger signal on D401, point 13) to the main time-base trigger amplifier.

In the composite triggering mode, which is only functional when also ALT mode is selected, point 4 of S22-A is open circuited, consequently, transistors V408 and V458 and also transistors V457 and V407 are now controlled by a signal coming from the vertical logic circuit via R1622 and R494. This signal brings transistors V458 and V408 alternately into conduction to enable triggering on the channel being displayed.

Transistor V409 inverts the logic input signal to allow alternate switching of the two channels.

Diodes V454 and V404 are alternately conducting and the A and B trigger signals are alternately routed to the MTB trigger amplifier.

Presets R431 and R481 enable the switching points of the diodes V404 and V454 to be set.

Presets R478 and R428 compensate for any current differences between the A and B triggering signals to enable the same current to be delivered to the trigger amplifiers.

6.2.1.5. Vertical display mode logic

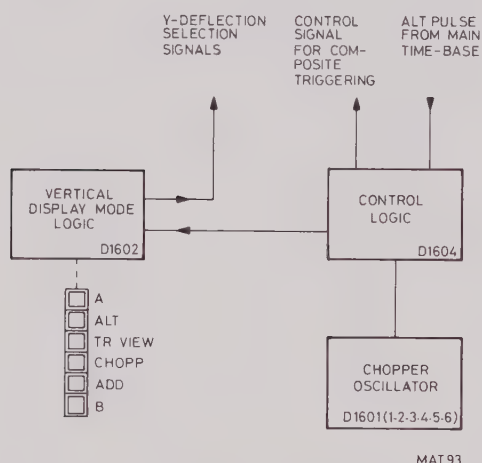


Fig. 6.3. Vertical display mode logic

This logic consists of digital circuits employing dual-in-line TTL integrated circuits. Vertical mode selection is made by selector switch S1.

The outputs that can be selected by the vertical display mode selector switch S1 are:

- channel A only
- channel B only
- TRIG VIEW signal only
- channels A and B added, chopped or alternated
- TRIG VIEW signal and channels A and B, chopped or alternated.

Positive logic is used in the digital circuits, the levels being as follows:

logic "1" = +5 V (high)

logic "0" = 0 V (low)

The different functions of the logic circuits are now described according to the vertical display mode selector switch S1.

- A**
- selects channel A only. Via switch S1 the S input (point 7) of flip-flop D1604 is set to +5 V and the R input (point 8) to 0 V. The "high" level at output 10 is fed via two NOR circuits and R1628 to R283 in the A channel preamplifier to open the A channel signal path.
At the same time the control signals for the B and the TRIG VIEW channel are 0 V.
- B**
- selects channel B only. Via switch S1 the S input (point 7) of flip-flop D1604 is set to 0 V and the R input (point 8) to +5 V. The high level at output 11 is fed via two NOR circuits and R1627 to R383 in the B channel preamplifier to open the B channel signal path.
At the same time the control signals for the A and the TRIG VIEW channel are 0 V.

ADD

- adds channels A and B. Inputs 2 and 5 of NOR circuits D1603 are connected to +5 V via switch S1, consequently both outputs 1 and 4 are low. They are fed via the NOR circuit and the resistors to R283 and R383 in the A and B channel preamplifiers to open both signal paths simultaneously. The TRIG VIEW control signal is 0 V then.

TRIG VIEW

- selects the trigger signal only. Via switch S1 a +5 V is applied to points 4 and 5 of NAND D1607 (4-5-6). Output point 6 is fed via NOR D1602 (1-2-3) and resistors R1629 to R547 in the trigger view amplifier to open the trigger view signal path.
- The channel A and B control signals are 0 V then.

CHOP

- selects channels A and B chopped. In this position the chopper generator, which consists of NAND circuits D1601 (4-5-6) and D1601 (1-2-3), is switched into the circuit by a +5 V applied to input 4. The frequency of oscillation is 2 MHz. The output signal is fed via two NANDS to the clock input of flip-flop D1604. The only flip-flop of interest now is the first one. It divides the incoming frequency by two and switches at a frequency of 1MHz. The resulting high switching levels on the outputs 10 and 11 of the flip-flop provide the chopping signals for the A and B channels.

The control signal for the TRIG VIEW channel is blocked in this situation.

During switching over in the CHOP mode, the c.r.t. is blanked by pulses supplied via transistor V1601 to R2002 of the blanking stage.

ALT

- selects channels A and B alternately for display. The circuit acts as in the CHOP mode, only the chopper generator is blocked and the circuit is driven now by the much slower switching signal applied to input 2 of NAND D1608 (1-2-3).

This switching signal is derived from the main time-base generator (V903) or the alternate time-base logic. These pulses switch the circuit at the end of each sweep and the channels A and B are alternately displayed.

In ALT TB mode the circuit is switched at the end of every two sweeps.

The control signal for the TRIG VIEW channel is 0 V.

ALT	TRIG
VIEW	VIEW

- selects channels A and B and TRIG VIEW alternately. So three signals can be made visible on the screen, but only one at a time is written.
For the generation of the control signals see Fig. 6.4. Clock pulses are here the alternate pulses.

TRIG
VIEW CHOP

- selects channels A and B and TRIG VIEW chopped. Three signals can be made visible on the screen, but now in chopped mode.

For the generation of the control signals see Fig. 3.4. Clock pulses are here the chopper generator output pulses.

Composite triggering

The output signal of point 10 of flip-flop D 1604 is applied via R 1622 to resistor R 494 in the trigger source selector.

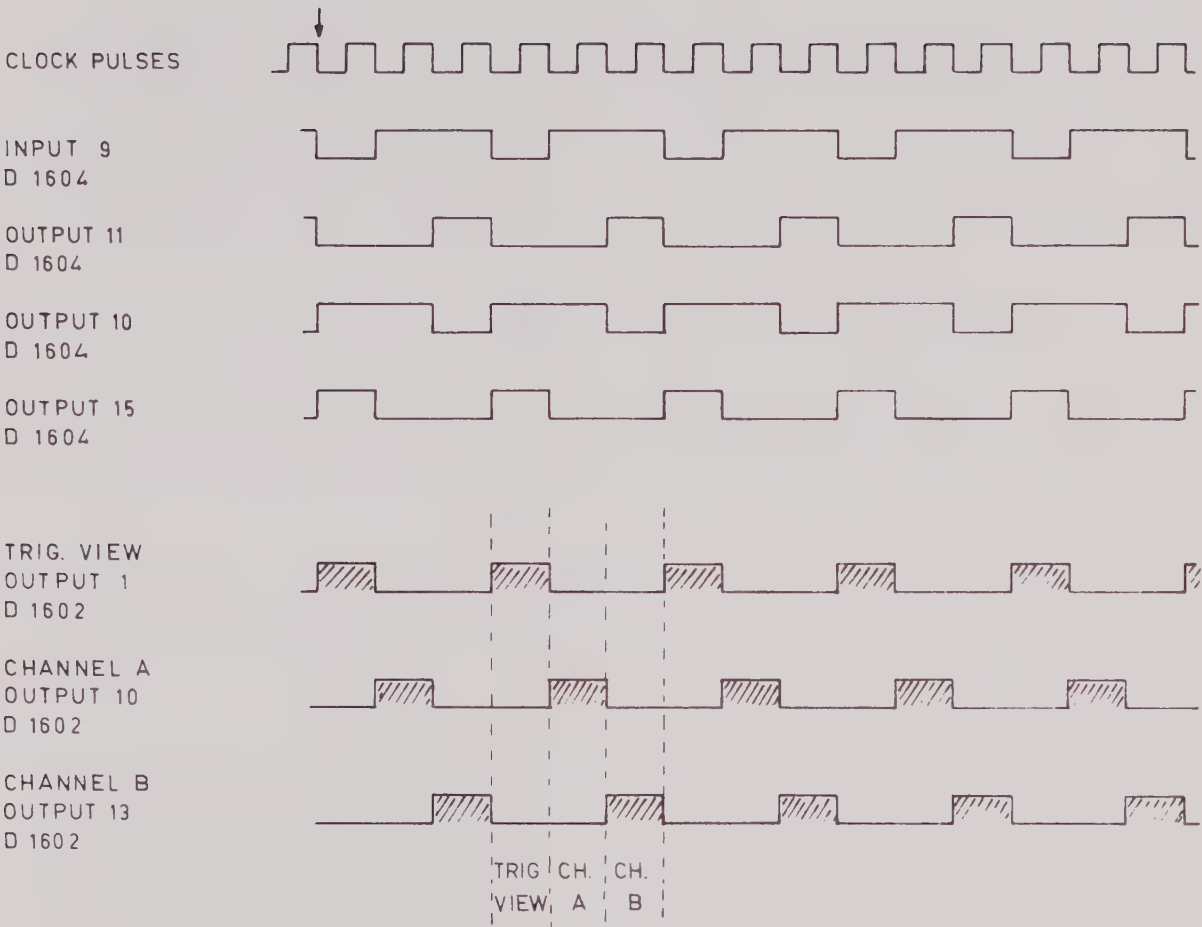


Fig. 6.4. Generation of control pulses

6.2.1.6. Channel switching and delay-line driver

The signal collector outputs from channel A (D203/12,14) are coupled to the bases of the transistors of the shunt-series-feedback amplifier V502/V504. Each collector output normally draws, via resistors R279 and R282, 10mA from the current source V501/V503.

When the A channel is switched off the signal transistors in D203, connected with pin 12 and 14 are blocked and two times 10mA is interrupted. Now two compensation transistors in D203 connected with pin 13 and 15 are switched on so that they now draw together 20mA current from the +11.4V rail via R502, R501 and R507. As a result D203 always draws a current of 20mA. With the channel switched on the current flows via R279 and R282 to pin 14 and 12. With the channel switched off the current flows via R281 to pin 13 and 15.

In a similar way as described above channel B and the TRIG VIEW channel are switched and connected with series feedback amplifier V502/V504 and current source V501/V503. Independent from the number of channels that is switched on at a time the currents from V501, V503, V502 and V504 stay constant.

The collector outputs of transistors V502 and V504 are direct-coupled to the bases of the output transistors of the delay-line stage (points 3 and 6 respectively of integrated circuit D501). The collector outputs on points 2 and 7 of D501 feed the combined output resistor R552, the value of which matches the characteristic input impedance of the delay-line.

A delay-line is used with a characteristic output impedance of 75 ohms. From the delay-line, the signals are routed to the vertical output amplifier stage, via input resistors R602 and R609, which terminate the delay line in 75 ohms. Transistors V601 and V602 in common-base configuration provide the first stage of the vertical output amplifier.

6.2.1.7. Final Y amplifier

The voltage signals present on R604 and R613 are applied to the bases of transistors (point 3 and point 6) of integrated circuit D601.

The emitters of these transistors (points 4 and 5) are fed from a constant-current source, V606, via transistors V607 and V603. The base of V607 is controlled via V608 from the TRACE SEP; potentiometer R6 on the time-base circuit.

This potentiometer varies the current on the side of the balanced amplifier to give trace separation in the ALTERNATE TB mode.

The networks R634, C613, R636, C614 and C616 provide delay-line correction at different frequencies. High frequency compensation for this stage is achieved by V609, C617 and V611, C618 adjusted by preset R646. The NTC resistor temperature-controls the vari-cap capacitance and compensates for increase in temperature.

Integrated circuit D601 and thin-film circuit D602 form a shunt-series feedback circuit, followed by a cascode amplifier with voltage output developed across the load resistors inside D603.

The Y plates of the c.r.t. are fed via series chokes L601 and L602 damped by the parallel resistors R662 and R664.

Together with the capacitance of the c.r.t. plates, this forms a series resonant circuit to lift the gain at the high frequency end of the bandwidth. Preset R654 provides a measure of gain adjustment (20 % approx.) to allow for different c.r.t. sensitivities.

It controls the quiescent current of the diodes and thus the gain of the D601 amplifier stage.

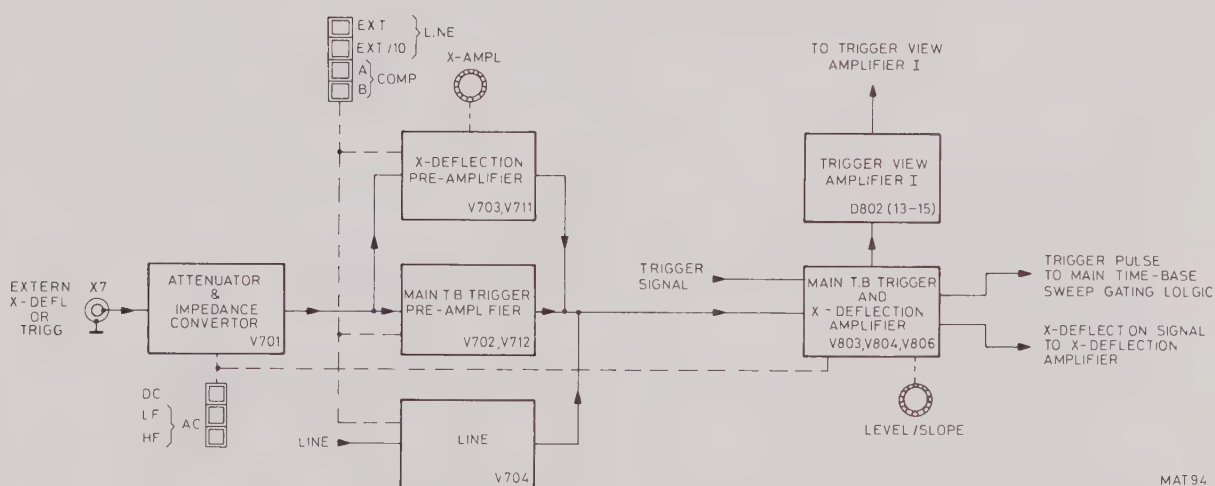
Any unbalance in the c.r.t. deflection plates can be corrected for by the line centring preset R658, which provides a compensating current for one side of the balanced output stage.

6.2.2. Main time-base triggering

The trigger source switches for triggering the main time-base generator, can select any of the following input sources.:

- an internal signal from the vertical A channel
- an internal signal from the vertical B channel
- an internal composite signal of channel A and channel B
- a signal derived from the mains supply
- an external source.

All these sources can be used for both triggering and X Deflection purposes. Source selection is done by means of a trigger selector switch S22.



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Fig. 6.5. Main time-base trigger circuit

6.2.2.1. Main time-base trigger source selector and preamplifier

The signal which is applied to the external trigger or X-deflection input X7 is attenuated via R702 and R703 by a factor of 10 in the EXT ÷ 10 mode.

When DC coupling is selected with switch S20, a DC path is formed via the resistors R707 and R708 to input 3 of D701. In the LF and HF mode the DC path is blocked. The l.f. component of the signal is fed via capacitor C704 to point 3 of D701 and the h.f. component is then fed via capacitor C703 to FET transistor V701. The output signal from V701 and D701 is then applied to the bases of the transistors V712 and V711.

In the modes A, B, COMP and LINE the junction of R714 and R718 is connected to ground via switch S2, transistors V702 and V703 are conducting thus blocking the signal paths via the diodes V708 and V709.

In LINE mode R722 is not longer connected to ground and transistor V704 is blocked. Diode V707 will conduct and the signal path for the LINE signal is opened.

When modes EXT or EXT ÷ 10 are selected there is no voltage applied via S22 to the junction of R714 and R718. In these modes there is only one of the transistors V702 and V703 conductive and the other one is then blocked.

If V702 is conductive, the signal path via diode V709 will be blocked. The signal path via diode V708 will be blocked when V703 is conductive.

If V702 or V703 conducts depends on the setting of switch S2.

There is no voltage applied via S2 to R716 and R717 in normal horizontal deflection by MTB and/or DTB signals. Transistor V702 is blocked, V706 and V703 conduct and the signal path via diode V709 is opened.

In EXT-X DEFL mode a +5 V signal is applied to R716 and R717 and V702 is conducting. At the same time V706 and V704 are blocked and the signal path via diode V708 is opened. The X-AMPL potentiometer R18 in the emitter circuit of V711 is now brought into the circuitry.

6.2.2.2. Main time-base trigger amplifier

The main time-base trigger amplifier consists of an input stage, coupling filters and a final amplifier. In this trigger amplifier, there is an output taken off for trigger view.

The signal current from the intermediate amplifier (channel A, channel B, or composite) is fed via the trigger source selector circuit to the emitter of V803. The output from the trigger source (EXT, EXT ÷ 10, or LINE i.e. mains frequency) is also fed to the emitter of V803.

This transistor, connected in common-base configuration, is coupled to the shunt feedback stage V804, V806. The output of this stage is diode-coupled to the filters for the various coupling modes.

By means of these filters, the input frequency range of the trigger circuit can be set.

The desired filter is switched in by biasing the appropriate switching diodes in the forward direction via two resistors. For example the DC and TTL position, selected by switch S20, are switched in by the — 11,4 V which causes diodes V 809 and V 812 to conduct. The LF and HF modes are selected in a similar way. The filter section is coupled to an emitter-follower V 813, which compensates for the temperature drift of transistor V 804.

On the trigger amplifier, the trigger view signal and the trigger signal are split up by means of two amplifier stages.

The two transistors V814 and V816 accept the trigger signal. The transistors V817 and V 818 accept the trigger level voltage.

The level voltage can be varied continuously with front panel LEVEL potentiometer R7, but in TTL mode (selected with S20) the level depends on the setting of adjusting potentiometer R 860.

The trigger view gain can be varied by means of preset potentiometer R 842 in the emitter circuit of transistors V 814 and V 816.

The collectors of transistors V 814 and V 816 provide the trigger view output and the collector current of transistors V 817 and V 818 are fed to the shunt feedback stage V 821 and V 822 respectively, thus providing the trigger signal.

In the negative position of the +/– SLOPE switch S7, the trigger signal is taken from one of the collectors via transistors V 824 and V 827 and in the positive position via transistors V 823 and V 826.

+/– SLOPE switch S7 determines the polarity of the trigger signal. In the closed position a 0 V signal causes V 827 to conduct the negative trigger, and also switches off V 829. In the open position, V 829 is switched on and the positive trigger which is routed via V 826 and V 827 is blocked.

In this way, the appropriate trigger signal appears at the combined emitters of transistors V 826 and V 827.

This trigger signal is routed via a Schmitt-trigger formed by D 802 (12-13-15), R 2662 and R 2664.

The gap of the Schmitt-trigger is 50 mV. Only when TTL mode is selected the trigger signal will be routed via a Schmitt-trigger which is formed by D 802 (10-11-14), R 2661 and R 2663. The gap of this Schmitt-trigger is 120 mV. The signal paths are selected via transistor V 831 which is controlled by the trigger mode selector switch S20.

In TTL mode, transistor V 831 is blocked by a —11,4 V on its base. Its collector is high and the signal path via Schmitt-trigger D 802 (10-11-14) is opened, the other one blocked. In the DC, HF and LF mode, transistor V 831 conducts by a positive voltage on its base via R 2669 and R 2672. The signal path via Schmitt-trigger D 802 (12-13-15) is opened and the other one blocked. The resulting MTB trigger signal on the output 14 of D 802 is applied to the “Event counter” and also to the main time-base sweep gating logic if no “Events before MTB” is selected with switch S 25 B.

If "Events before MTB" is selected with switch S 25 B, transistor V 832 will be blocked. This results in blocking the MTB trigger pulse path via D 802 (2-4-5) to the main time-base sweep gating logic. The main time-base will now be triggered with the first DTB trigger pulse via D 802 (3-6-7) after COUNT READY is generated. The COUNT READY pulse is fed via D 1202 (10-11-14) to the D-type flip flop D 901 in the main time-base sweep gating logic. The COUNT READY signal is also applied to D 802-7 to block the DTB trigger signals as long as there is no COUNT READY signal.

If "Events before MTB" is selected, the DTB trigger signal path to the delayed time-base sweep gating logic is blocked via a control signal to diode V 1225.

When "Events before MTB" is not selected, will transistor V 832 conduct. This results in blocking the DTB trigger signals and the COUNT READY signal.

The MTB trigger signal is passed through to the main time-base sweep gating logic, input 10 of D 901 is continuously "high" and the main time-base functions in the normal way.

6.2.3. Main time-base generator

The main time-base generator comprises a sweep gating logic, a sweep generator, a hold-off circuit and an auto sweep circuit.

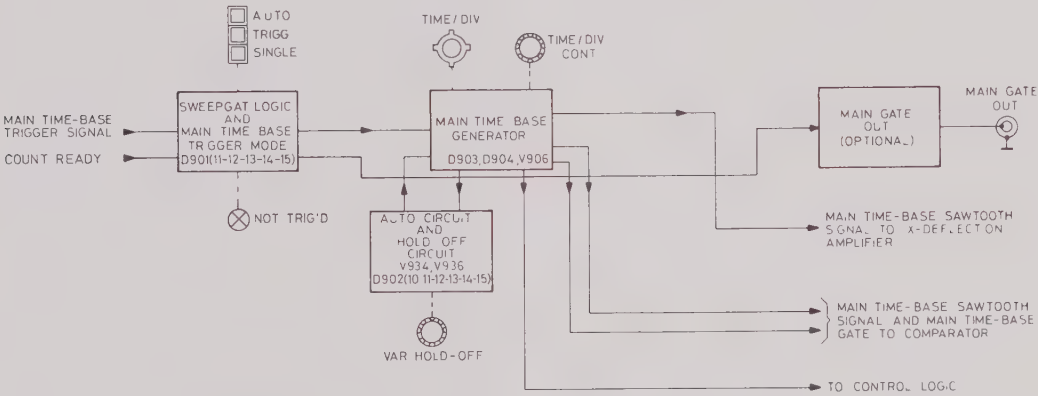


Fig. 6.6. Main time-base generator

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The operation of the main time-base generator is based on the principle that a capacitor charges linearly when a constant-current source is applied, and can be periodically discharged rapidly by means of an electronic switch. In this way, a linear saw-tooth waveform is generated.

The constant-current source consists of transistors V913, V914 and integrated circuit D903. The emitter voltage of V914 has the same potential as point 3 of D903, therefore a constant voltage exists across the series circuit of R926 and the charging resistors on switch TIME/DIV S15. This voltage, and thus the charging current may be varied by means of potentiometer R11 and the preset potentiometers R911 and R913, which compensate for the tolerances of the timing capacitors.

In the TRIG. position V931 is switched off because of the +5,2 V applied to its base by switch S8 (AUTO). If point 14 of the master slave flip-flop D901 is logic "high" due to a trigger pulse, V929 will also be switched off.

Consequently, its collector will be negative and switching transistors V906, V907 will be turned off (discharge switch open) and the timing capacitors C916 and C917 in parallel (and C912, C913 or C914 as selected) will be charged. This charging voltage is applied via the buffer stage consisting of the Darlington pair emitter-follower V922, V923 (h.f. path) and via the operational amplifier D904 together with V924 (l.f. path) to point 12 of the R; S; flip-flop D902. This flip-flop reaches its switching voltage when the time-base-saw-tooth voltage rises to approximately +4,3 V. Output 14 will then be "high" and output 15 will be "low". Since the collector of V937 is positive (see operation of AUTO circuit), diodes V927 and V926 will conduct and the "high" output on point 14 of D902 will be applied to point 12 (S input) of flip-flop D901. This results in a "low" output on point 14 of D901 irrespective of the state of the other inputs. The "low" output causes V929 to start conducting and its collector becomes less negative. Consequently, switching transistors V906, V907 conduct (discharge switches closed), the timing capacitance is discharged and point 12 of D902 drops below the switching level. Transistor V944, the base of which was turned on by the "high" output (point 14) of D902, is now switched off.

In turn, transistor V956 (discharge switch for the hold-off circuit) is switched off and allows the hold-off capacitance (C928 and C926, C927 as selected) to be charged by current source V954, D906. The voltage on point 3 of D906 is derived from a resistor that carries the charging current of the time-base generator. Therefore, the charging current for the hold-off capacitance is proportional to that for the time-base capacitance, thus giving a constant relationship between time-base length and the hold-off time. Potentiometer R18 (HOLD-OFF) allows the length of the hold-off period to be increased by a factor of 10. When the voltage across the hold-off capacitance has risen to a value of approximately 4,3 V the flip-flop D902 will be switched to its original state (outputs 14 low, 15 high), via buffer stage V949, V948. The "low" state on the base of V944 causes it to conduct and turn on V956 to discharge the hold-off capacitance. As a result, point 10 of D902 drops below its switching level. The S input of D901 will also be low again, whereupon the clock input (point 11) will be effective. The D input (point 10) is coupled with a logic zero or the COUNT READY signal depending on the setting of the EVENT BEFORE MTB or DTB switches S 25 A and S 25 B. Due to this pulse the flip-flop is switched over, resulting in a low level on point 15 and a high level on point 14 to permit the new time-base sweep.

6.2.3.1. Free run AUTO-circuit

If as a result of a trigger pulse, the Q output (point 15 of D901) is low, V934 and V936 start conducting and provide a discharge path for capacitor C923. Resistor R957 has been selected so that the current through R958 is insufficient to bring the base-emitter voltage of V936 to 0,7 V; therefore, both transistors are cut off as soon as C923 has discharged, provided that the Q output has switched to "high" in the meantime. The voltage on the negative side of C923 is then approximately +3,5 V and V937 is turned off, as a result of which diodes V926 and V927 are able to transfer the pulse on D902 output 14 to input 12 of D901. Transistor V931 is turned off because its base is held at +5,2 V via R959, R960 and R962 (switch S8 (AUTO) is interrupted in the AUTO position). Thus, with a trigger signal input the time-base operates in the same way as in the TRIG position.

However, in the absence of a trigger signal, when D901 output 15 is "high", capacitor C923 will be slowly charged to approximately -6 V. If before this charging time (0.1 s approx.), point 15 turns to "low" (due to a trigger signal), C923 is discharged again before V937 starts conducting. As a result, V937 remains switched off and the instrument is still triggered.

If the voltage across C923 is permitted to charge to -6 V (i.e. no trigger signals appear), V937 starts to conduct and the resulting negative on its collector blocks diodes V926 and V927. At the same time, the base voltage of V931 drops. Consequently, the pulse on output 14 of D902 is no longer transferred to input 12 of D901, but is fed direct to the switching transistors V906, V907 via diode V932 and transistors V931 and V929.

In this way, the time-base generator runs automatically without the intervention of a trigger pulse. Transistor V937 is conductive when the time-base generator is not triggered. The base of V939 is then low, as a result of which the transistor conducts and the NOT TRIG'D lamp (V2) lights.

6.2.3.2. SINGLE SHOT mode

In the trigger position SINGLE, the time-base hold-off capacitors are short-circuited by diode V953 and switch contacts S8 (AUTO) and S8 (TRIGG).

The flip-flop D902 must then be reset manually by the RESET button S8 (SINGLE), which applies +5,2 V via R975, V946 to input 10. After input 10 has been brought to a high level and the RESET button released, triggering can occur, but on one event only as the flip-flop is not reset automatically.

In the SINGLE mode, V937 is permanently turned off via R965 by S8 (AUTO) and S8 (SINGLE). Since diodes V941 and V942 are now conductive, the pulse on output 14 of D902 will be transferred to the base of V939.

Consequently, the NOT TRIG'D lamp will light during the period when output 14 of D902 is low, i.e. from the moment the RESET button is pressed until the end of the time-base sweep initiated by the incoming trigger pulse of the event under observation.

6.2.4. Delayed time-base triggering

The trigger source switches for triggering the delayed time-base generator, can select any of the following input sources.

- an internal signal from the vertical A channel
- an internal signal from the vertical B channel
- an internal signal derived from the main time-base to start the delayed time-base immediately after the selected delay time
- an external source

Source selection is done by means of a trigger selector switch S21.

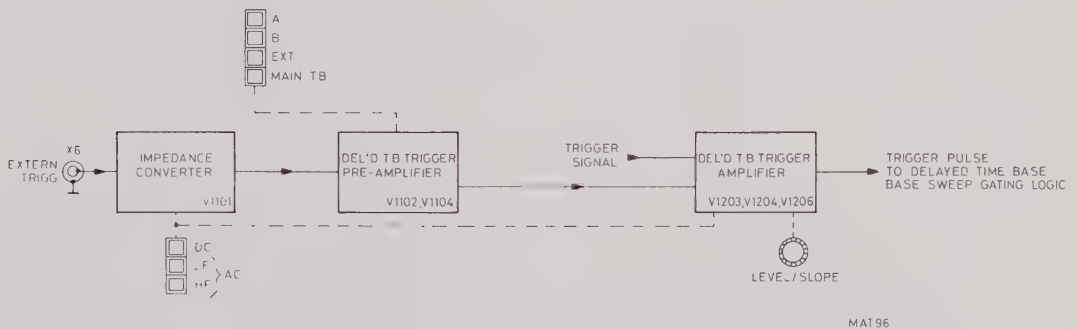


Fig. 6.7. Delayed time-base trigger circuit

6.2.4.1. Delayed time-base trigger source selector and preamplifier

The signal which is applied to the external trigger input X6 is fed via the input stage consisting of FET transistor V1101 and integrated circuit D1101 to the base of V1104.

When DC coupling is selected with switch S19, a DC path is formed via the resistors R1103 and R1104 to input 3 of D1101. In the LF and HF mode the DC path is blocked. The l.f. component of the signal is fed via capacitor C1102 to point 3 of D1101 and the h.f. component is then fed via capacitor C1101 to FET transistor V1101. The output signal from V1101 and D1101 is then applied to the base of transistor V1104.

In the modes A, B and MTB the emitter of transistor V1102 is connected to the +11,4 V via switch S21, transistor V1102 is conducting thus blocking the signal path via the diode V1103.

When mode EXT is selected, there is no voltage applied via S21 to the emitter of transistor V1102. This transistor is blocked and the signal path via diode V1103 is opened.

The gain of the low frequency path is set by adjusting the resistor divider ratio from which the output is sampled. Adjusting is done with preset potentiometer R1118 (L.F. corr.).

6.2.4.2. Delayed time-base trigger amplifier

The delayed time-base trigger amplifier consists of an input stage, coupling filters and a final amplifier.

The signal current from the intermediate amplifier (channel A, channel B or composite) is fed via the trigger source selector circuit to the emitter of V1203. The output from the trigger source (EXT) is also fed to the emitter of V1203.

This transistor connected in common-base configuration, is coupled to the shunt feed-back stage V1204, V1206. The output of this stage is diode-coupled to the filters for the various coupling modes.

By means of these filters, the input frequency range of the trigger circuit can be set.

The desired filter is switched in by biasing the appropriate switching diodes in the forward direction via two resistors. For example, the DC and TTL position, selected by switch S19, are switched in by the -11,4 V which causes diodes V 1209 and V 1213 to conduct. The LF and HF modes are selected in a similar way.

The filter section is coupled to an emitter-follower V1216, which compensates for the temperature drift of transistor V1204.

The two transistors V1237 and V 1238 accept the trigger signal and the trigger LEVEL voltage respectively. The LEVEL voltage control R5 permits variation of the trigger level of the signal.

The collector currents of V1237 and V1238 are fed to the shunt feedback stage V1219 and V1218 respectively, thus providing the trigger signal.

In the positive position of the +/- SLOPE switch S6, the trigger signal is taken from one of the collectors via V1224 and V1223, and in the negative position via V1221 and V1222.

+/- SLOPE switch S6 determines the polarity of the trigger signal. In the closed position a 0 V signal causes V1221 to conduct the negative trigger, and also switches off V1224. In the open position, V1224 is switched on and the positive trigger is routed via V1223 and V1221 is blocked.

In this way the appropriate trigger signal appears at the combined emitters of transistors V 1222 and V1223.

This trigger signal is routed via a Schmitt-trigger formed by D 1203 (12-13-15), R 1279 and R 1281.

The gap of the Schmitt-trigger is 50 mV. Only when TTL mode is selected the trigger signal will be routed via a Schmitt-trigger which is formed by D 1203 (10-11-14), R 1277 and R 1278. The gap of this Schmitt-trigger is 120 mV.

The signal paths are selected via transistor V 1226 which is controlled by the trigger mode selector switch S19.

In TTL mode, transistor V 1226 is blocked by a -11,4 V on its base. Its collector is high and the signal path via Schmitt-trigger D 1203 (10-11-14) is opened, the other one blocked.

In the AC, HF and LF mode, transistor V 1226 conducts by a positive voltage on its base via R 1289 and R1284. The signal path via Schmitt-trigger D 1203 (12-13-15) is opened and the other one blocked.

The resulting DTB trigger signal on the output 14 of D 1203 is applied to the "Event counter" and also to the delayed time-base sweep gating logic if no "Events before DTB" is selected with switch S 25 A.

If "Events before DTB" is selected with switch S 25 A, transistor V 1227 will be blocked. This results in blocking the DTB trigger pulse path via D 1203 (3-6-7) to the delayed time-base sweep gating logic. The delayed time-base will now be triggered with the first DTB trigger pulse via D 1203 (3-6-7-) after COUNT READY is generated. The COUNT READY pulse is fed via D 2403 (12-13-15) to the D-type flip flop D901 in the delayed time-base sweep gating logic. The COUNT READY signal is also applied to D 1203 - 4 to block the DTB trigger signals as long as there is no COUNT READY signal.

6.2.5. Delayed time-base generator

The delayed time-base generator comprises a sweep gating logic, a sweep generator, a comparator and an end of the sweep detector.

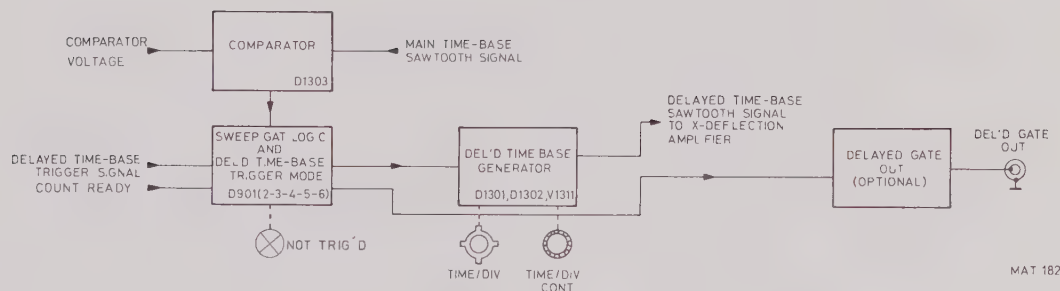


Fig. 6.8. Delayed time-base generator

Before considering these stages in detail, the general principle is briefly described.

Basically, the sweep gating logic, under the control of trigger signals from the trigger circuit and also feedback pulses from the end-of-the-sweep detector circuit, supplies square-wave pulses to the switching transistors V1309 and V1311 of the sawtooth generator. The time-base capacitors (effectively in parallel with the switching transistor) are charged linearly through a constant-current source to provide the forward sweep, and are discharged rapidly by the switching transistor to provide the flyback period. The resulting sawtooth is fed via the X-deflection selector to the X-final amplifier.

6.2.5.1. Delayed time-base sweep generator

The sweep speed or time coefficient is determined by the value of the time-base capacitance in circuit, and also by the magnitude of the charging resistor selected.

The time-base capacitors C1311, C1312 are always in circuit, the capacitors C1307, C1308 and C1309 are selected by the transistors V1319, V1322 and V1323 respectively. These transistors operate as electronic switches and are either fully cut-off or fully-conducting. They are switched on by the application of a positive voltage on their bases from the TIME/DIV switch S13. According to the position of S13 the transistors switches in one of the capacitors in parallel with C1311 and C1312.

As mentioned, the sweep speed is also dependent upon the magnitude of the accurate constant-current supplied by transistors V1317 and V1318. This current can be adjusted in steps by selecting the emitter resistance of V1318 by means of the TIME/DIV switch S13.

Continuous control of the charging current can be effected by varying the drive to point 3 of integrated circuit D 1301 with the continuous sweep control, TIME/DIV potentiometer R10.

Potentiometer R1326 enables the sweep speeds of the delayed time-base generator to be equalized to those of the main time-base generator.

Together with C1307 and C1309, transistors V1314 and V1312 are switched into the circuit by a +5.2 V voltage from the TIME/DIV switch S13. In these positions potentiometers R1323 and R1322 provides a fine adjustment for the timing circuit.

The discharge circuit for the time-base capacitors consists of transistor V1311, which is driven by the sweep gating logic.

The resulting sawtooth voltage is fed via an l.f. path and an h.f. path to the X-deflection selector. The l.f. path consists of integrated circuit D1302 and transistor V1328 and the h.f. path consists of transistors V1326 and V1327.

6.2.5.2. *Delayed time-base end of the sweep detection circuit*

This circuit prevents the sweep gating logic from responding to trigger pulses before the time-base capacitor has fully discharged. The sawtooth output is applied to point 7 of SR flip-flop D902.

At the end of the time-base sweep, output 2 of the SR flip-flop D902 will be "high" and output 3 will be "low". These logic levels are transferred to pins 5 and 4 respectively of D901 irrespective of the state of the comparator D 1303. As a result, the $\bar{Q}$ output point 3 becomes "low" and the timing capacitors are discharged via V1311, since the flip-flop D902 is not reset until the end of the main time-base sweep (D902-15 on MTB connected via a differential network to D902-5 on DTB). This situation will persist until the next sweep of the main time-base. If the main time-base sweep is completed before the end of the delayed time-base, the R and S inputs (5 and 4) of D901 are switched over and the delayed time-base capacitors also are discharged. The system can now be triggered again.

6.2.5.3. *Comparator circuit and sweep gating logic*

The comparator consists of an integrated circuit D 1303. Transistor (points 6-7-8) is a constant-current source for the transistors (points 1-2-3 and 3-4-5-) of a differential amplifier.

The comparator voltage generated by the dual d.a.c. circuit is fed to the base of transistor (points 3-4-5). The sawtooth voltage of the main time-base generator is fed to the base of the other transistor. As soon as the amplitude of the sawtooth exceeds the comparator voltage, a high level is passed from D 1303, pin 5, to input 4 of master-slave flip-flop D901 (R input), and a low level from D 1303, pin 1 to S input 5 of D 901.

The $\bar{Q}$ output on point 3 will then be high, with as result that V 1304 and the time-base capacitor discharge switches V 1309 and V 1311 will be turned off. This is the situation in the MTB position of the switch S21. In positions A, B or EXT of delayed time-base trigger selection switch S21, point 4 of D 901 can be switched to logic O level via switch S 21 and diodes V 2554 or V 2556. (Not possible when event before MTB is selected with S25). The delayed time-base then starts first upon receipt of trigger pulses on clock input 6, after the S input has dropped to the low level.

6.2.5.4. Dual D.A.C.

In the MAIN TB position of the delayed time-base trigger selection, the sawtooth voltage generated by the main time-base is compared with a d.c. voltage produced by the dual D.A.C. that is proportional to a number put into the memory of the micro-processor by means of the SET control.

The number put into the micro-processor memory is from 0 to 2000 and it corresponds to the delay required on the time-base; i.e., 0 represents no delay and 2000 represents maximum delay. In relation to the divisions on the c.r.t. screen, as 2000 represents 10 divisions, each division is occupied by 200 increments.

If the ΔT mode is selected, then the dual D.A.C. produces two d.c. voltages to provide starting times for the two delayed time-bases during the MTB sweep.

These two voltages are fed alternately to the comparator to produce the two delayed time-base displays.

Following alternate sweeps of the main time-base, the 1st delayed time-base is displayed, and then the 2nd delayed time-base.

In the dual D.A.C. circuit, the two d.c. voltages are formed by a pulse-width modulator circuit using the four Up/Down counters D2601, D2602, D2603 and D2604.

Using fixed-frequency pulses derived from the clockpulse of the microprocessor, the pulse width of the output from these counters is varied as a function of the number stored in the memory.

This variable pulse width is made as follows:

Each of the four digits of the total-delay number 2000 is served by one of the four counters, integrated circuits D2601 to D2604, where D2601 serves for the most-significant digit and D2604 for the least-significant digit.

As the maximum count is 2000, the most-significant digit counter D2601 only counts the number 0, 1 or 2.

Counting is achieved in repetitive cycles of four steps.

Step 1 — the microprocessor loads these counters with the number representing the 1st delay time and counts from it up to 2000.

Step 2 — the microprocessor loads these counters with the number representing the 1st delay time and counts from it **down** to 0.

The total number of count pulses in these two steps is 2000 independent of whatever delay time is chosen; i.e. the frequency of these two steps is always the same.

Step 3 — the microprocessor loads the counters with the number representing the difference between the starts of the two delayed time-bases; i.e., ΔT , and counts from it **up** to 2000.

Step 4 — the microprocessor loads the counters again with ΔT and counts from it **down** to 0.

As in steps 1 and 2, the total number of count pulses in steps 3 and 4 are 2000.

In this way, we have pulses of fixed frequency, with a variable pulse-width from 0 to 50 % depending on the selected delay times.

The counter D2603, D2603 and D2604 produce a MIN/MAX high output when the numbers they contain reach 0 in the count-down mode and 9 in the count-up mode.

These outputs together with the CLOCK provide inputs for an AND gate comprises of diodes V2601, V2602, V2603 and V2604. Therefore, when all M/M outputs and the clock are present (all counters 0 or 9) a MIN/MAX total, or terminal count, pulse is present on input 5 of NAND gate D2607.

As the maximum number counted is 2000, as stated, the most-significant digit is only 0, 1 or 2. Counter D2601 has therefore two spare bits left, which are used to give information about the four counting steps.

Input D7 is used to give mode information, whether delay mode (logic 1) or ΔT mode (logic 0).

Input D6 gives count up (logic 0) or count down (logic 1) information.

NAND gates D2607 provide a terminal count output pulse (logic 0) on points 6 and 8 at the end of every step.

End of steps 2 and 4 - terminal count (logic 0) on point 6 of D2607

Input conditions:

Q6 **down** pulse logic 1 to point 1 of D2607

Logic 0 on Q4 [1 (000) bit output] via inverter as logic 1 to point 4 of D2607

Logic 0 on Q5 [2 (000) bit output] via inverter as logic 1 to point 2 of D2607

MIN/MAX total logic 1 to point 5.

End of steps 1 and 3 - terminal count (logic 0) on point 8 of D2607

Input conditions:

- Q6 up pulse logic 0 via inverter as logic 1 to point 9 of D2607
- Logic 1 on Q5 to point 10 of D2607.
- (+5 V on pin 13) of D2607.

This terminal count pulse is routed together with the mode information (delay or ΔT) via gates D2606 and D2608 to the flip-flops D2609 to produce fixed-frequency pulses with widths proportional to the delay or ΔT times.

The method of producing these pulses is best understood by taking specific examples.
Assume therefore a delay of 500 increments and a ΔT of 200 increments.

- Step 1
(Delay Up)

The microprocessor loads the counters with the delay time, 500 in this example, and during this step counts up to 2000.

As we are in the delay mode, the Q7 output of D2601 is at logic 1. Reset input R2 of D2609 is also at logic 1 and so is inactive.

The set input S2 is also at logic 1 (inactive) because although there is a "1" on point 4 of NAND gate D2608, in the absence of a terminal count pulse, there is a "0" on point 5.

As seen in Fig. 6.9., there is therefore no pulse on the Q2 output to produce the delay voltage pulse.

However, as the counter reaches 2000, a terminal count pulse occurs, and a logic 0 on output 8 of D2607 is inverted by D2606 points 13 to 12) to give a logic 1 on input pin 5 of NAND gate D2608. Together with the logic 1 on input 4 of gate D2608, this produces a logic 0 output to activate the set input S2 of the set/reset flip-flop D2609. This initiates a positive-going pulse on the Q2 output.
- Step 2
(Delay Down)

The micro-processor loads the counters again with the delay time, 500, but during this step it counts down to 0 and, as seen in Fig. 6.9. we get a positive pulse on Q2 of width proportional to 500. At the end of the step the output on Q7 drops to logic 0 and S2 goes to logic 1 (logic 1 on D2608 output 6, R2 goes to logic 0 and consequently the pulse on Q2 drops to logic 0.
- Step 3
(ΔT Up)

The counter is now loaded with the ΔT , in this example 200, and during this step it counts up to 2000.

In this mode, output Q7 of D2601 is at logic 0.

Reset input R1 is at logic 1, and is therefore inactive, because of inverter D2606 (point 9 to 8).

The set input S1 is also at logic 1 (inactive) because although input 1 of gate D2608 is at logic 1, in the absence of a terminal count pulse, input 2 is at logic 0.

As this step reaches 2000, there is a terminal count pulse and the set input S1 becomes low. This activates the lower flip-flop and initiates a positive-going pulse on the Q1 output as shown.
- Step 4
(ΔT Down)

The counter is again loaded with the ΔT pulses and counts down from 200 to 0. For the duration of this step there is a positive pulse output from Q1.

During the four steps of the cycle, the set/reset flip-flops D2609 produce one pulse on Q2 and one pulse on Q1. Pulse Q2 has a duty cycle that is proportional to the 1st DTB delay and Q1 has a duty cycle that is proportional to the time ΔT between the start of the 1st and 2nd delay time-bases. Both pulses can be selected to have pulse-widths of between 0 and 50 % (max. 2000 count pulses at a total of 4000).

The delay pulse on Q2 is integrated by RC filters R2609, C2601, R2611, C2602, R2612, C2603 and fed to input 3 of integrated circuit operational amplifier D2611.

The ΔT pulse on Q1 is integrated by RC filters R2621, C2604, R2622, C2606, R2623, C2607 and fed to input 3 of operational amplifier D2612.

The outputs from Q2 and Q1 are approximately +5 V, and as the maximum duty cycle is 50 % the voltages on input 3 of D2611 and D2612 are from 0 to 2,5 V depending on the pulse widths.

As the time-base sweep is 0,5 V per division, then the ten divisions require 5 V, so the operational amplifiers D2611 and D2612 have a gain of x2 each.

Zero adjustment potentiometers R2602 (delay) and R2613 (ΔT) ensure that the start of the time-base coincides with the minimum voltage. The amplification of the operational amplifiers can be adjusted by potentiometers R2606 (delay) and R2617 (ΔT), to ensure that the maximum comparator voltage coincides with the end of the main time-base trace.

Half of the delay voltage on output 6 of D2611 is combined in potentiometer R2626 with the ΔT voltage on output 6 of D2612 and fed to input 3 of the operational amplifier D2613 which has also a gain of 2. The output of D2613 now has a voltage that represents delay + ΔT ; i.e. the 2nd delayed time-base voltage.

Two d.c. voltages are now available for the two delayed sweeps and can be alternately switched to the comparator via V2614 (for DELAY and ΔT) and via V2606 (for DELAY) by means of the ALT pulse.

The ALT pulses are routed to points 1 and 2 of inverter D2617 to the trigger input of JK flip-flop D2618, and are also routed to input 4 of NAND gate D2617.

There are several possible modes of operation.

If only the 1st delayed time-base is required, then the delay output voltage on point 6 of D2611 is routed via V2606 to the comparator. Field-effect transistor V2606 conducts when its gate is high; i.e., when output 6 of the flip-flop D2618 is low, because V2609 inverts the output. This is achieved by a high input on K3 of D2618 from the ΔT switch (non-operated). In the 1st delay mode, the high output on point 8 of D2618 blocks V2614 via inverter V2613.

Zener diodes V2607 and V2611 compensate for the difference in voltage levels between the flip-flop outputs and the bases of the inverters V2609 and V2613.

The input on point 5 of D2617 and point 9 of flip-flop D2618 is dependent on the position of the ΔT switch. If this switch is depressed it is at logic 0. In the normal position the input is logic 1, then also p.8 of D2618 is logic 1. The ALT pulse from the main time-base goes then straight through the two D2617 gates to the logic unit.

When the ΔT switch is operated, both the 1st delay and the 2nd delay are available, and point 9 of D2618 becomes logic 0.

At every transition of the time-base flyback the flip-flop D2618 changes over, so that output points 6 and 8 are alternately switched between "0" and "1". Therefore, at every flyback period point 8 changes state, and has half the repetition rate of the MTB gate pulse.

This pulse is fed to point 9 of D2617 together with a "1" from D2617 output 6 to give an output to the pt 13 of D1608 of the alt. time-base logic.

The time-base switching sequence is:

- main time base with 1st delayed time-base intensified
- main time base with 2nd delayed time-base intensified.

The micro-processor receives a pulse (logic 1) from the set/reset flip-flop D2608 (comprising two NAND gates), via inverter D2669 (points 9, 10 to 8) to inform it that counting is complete.

Every cycle gives a "0" output (terminal count) pulse on points 6 or 8 of D2607, which is fed to input 10 of flip-flop D2608.

Point 8 becomes a logic 1 and normally point 13 is at logic 1, so the output point 11 is at logic 0. The inverter D2669 (points 10, 9 to 8) gives logic 1 to the RESTART 7,5 input of the micro-processor (point 7). This pulse starts a program which loads the new cycle of this counter circuit.

Therefore, when there is a terminal count, there is an interrupt of the micro-processor, which immediately answers the interrupt. In this way, counting can be continuous. When an interrupt is given, there is a delay while the micro-processor checks which cycle is occurring and loads these two counters.

The counters are loaded in two steps:

Load 1 The least-significant digit counters D2603 and D2604.

Load 2 The most-significant digit counters D2601 and D2602.

When the most-significant digit counters are being loaded, the negative pulse makes input 13 of flip-flop D2608 logic 0, and the flip-flop resets and RST 7,5 goes to 0.

After the load pulse is complete, input 13 becomes logic 1.

During a restart interrupt, the logic 0 on point 11 of D2608 is also fed to the four set/reset flip-flops (tri-state input 5) to isolate the outputs, so that the capacitors of the RC networks have no discharge path during an interrupt.

If there is an interrupt and output 11 of D2608 is at logic 0, and output 8 is at logic 1, the enable input of the first counter D2604 becomes logic 1, and therefore the counter is blocked; i.e. it is disabled.

Disabling the first counter is sufficient to disable all the counters, as these counters are enabled by the ripple clock (RC) of the first counter (point 13). The ripple clock of the least-significant digit counter feeds the enable input (EN) of the next-significant counter, and so on.

The μ P's clock signal on input 1 of D2669 is gated with the Load 2 signal in order to prevent that the enable input of D2604 changes if the clock input is low.

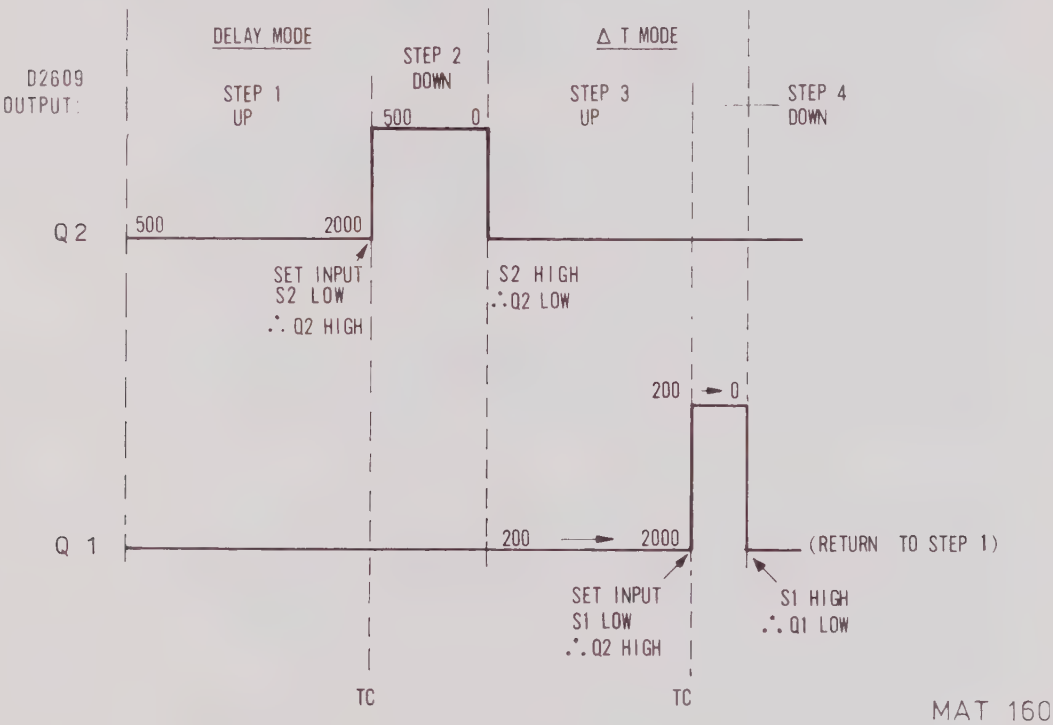


Fig. 6.9. Pulse diagram dual d.a.c.

6.2.6. Microprocessor circuitry

Introduction

Fig. 6.10. shows a blockdiagram with all circuits which are under control by the microprocessor.

From left to right on this diagram is indicated:

– Control interface

This circuit interpretes to the microprocessor the positions of the various front panel knobs and switches. The outputs of this interface is applied to the data bus.

The interface is selected by address lines A_0 and A_1 , combined with the $\overline{IOR}$ signal.

– ROM memory

A 2-k 8-bit read-only memory which contains the working program for the micro-processor. There is one spare socket for eventual memory expansion.

The specification address is selected with address lines $A_0 \dots A_{10}$ and the ROM memory itself is selected via its chip select input $\overline{CS}$ by address line A_{12} , combined with the memory read signal MEMR. ($= \overline{A_{13}} \cdot RD$)

$$CS = \overline{A_{12}} \cdot \overline{A_{13}} \cdot RD$$

The spare ROM is selected by address line A_{11} and the memory read signal MEMR.

$$CS_{SPARE\ ROM} = A_{11} \cdot \overline{A_{13}} \cdot RD$$

– RAM memory

A 1/4-k 8-bit read/write memory, consisting of 2 chips 1/4-k 4-bit, which is used for temporary storage of various data which are used by the microprocessor.

The specification address is selected by the address lines $A_0 \dots A_7$.

The RAM's are selected by address line A_{12} on the chip enable inputs $\overline{CE}$ and are controlled by the MEMW and MEMR signals.

$$\begin{array}{ll} \text{Write if} & A_{12} \cdot \overline{A_{13}} \cdot WR = 1 \\ \text{Read if} & A_{12} \cdot \overline{A_{13}} \cdot RD = 1 \end{array}$$

– Microprocessor

The microprocessor has 8 data lines and 16 address lines.

The first 8 address lines $A_0 \dots A_7$ are combined with the data lines $D_0 \dots D_7$. These lines are called $AD_0 \dots AD_7$. Depending on the logic level of the ALE signal the $AD_0 \dots AD_7$ lines contain an address or data.

The data bus (8 data lines $D_0 \dots D_7$) is connected to the microprocessor via two 4-bit bi-directional buffers.

The address lines $AD_0 \dots AD_7$ are connected to the address bus via two 4-bit latches which can take over address information, depending on the logic level of the ALE signal.

To prevent a too heavy load of the outputs of the microprocessor chip, the address lines $A_8, 9, 10, 13$ and the ALE and CLOCK signal are buffered.

The address lines A_{14} and A_{15} are used for addressing a VCO and a watch-dog circuitry respectively.

– Event counter

The event counter is used in the "Events before DTB", and "Events before MTB" modes.

The string of dividers by 10 is preloaded with a certain number by the microprocessor via latches. These latches are loaded by the microprocessor via the data bus and are selected by the address lines $A_0 \dots A_1$ and A_2 combined with the IOW signal.

– Dual d.a.c.

This circuit consists in principle of an up/down counter which produces a square wave signal.

The duty cycle of this signal depends on the value which is loaded into the counter by the data bus.

The square-wave signal is integrated to obtain the desired comparator voltage, to start the delayed time-base

This circuit is selected with address lines A_3 and A_4 combined with the IOW signal.

– LED display

The transistor circuitry which drives the 7-segment display is controlled by two latches for segment selection and one addressable latch for digit selection.

The latches are selected by address lines A_5 and A_6 respectively and the IOW signal.

The latches are loaded via the data-bus.

The microprocessor circuit works in memory-mapped I/O configuration.
Refer to Fig. 6.11.

6.2.6.1. CONTROL INTERFACE

In order to operate appropriately, the microprocessor must have information about the positions of the front panel switches and controls.
To achieve this, three 8-input/2-output multiplexers D2451-D2452 and D2453 can be addressed by the micro-processor address-lines A0 and A1.
The multiplexer's inputs are given to the microprocessor on datalines D0 ... D5 if the signal $\overline{\text{IOR}} = 0$.
With $\overline{\text{IOR}} = 1$, the multiplexer's outputs are high ohmic.
The information is fed to the microprocessor according to the table below.

A1	A0	D5	D4	D3	D2	D1	D0
0	0	TBG6	TBG5	TBG4	TBG3	TBG2	TBG1
0	1	TB uncal	TBS3	TBS1	TBS2	TBG8	TBG7
1	0	EXT X	Service Switch	MAIN TB	EVENT	DELAY	ΔT
1	1	DTB "OFF"	1/T	Push for FAST X 100	UP/ DOWN	(F) *	(L) *

If the switches are "on", then the inputs of the multiplexers are logic "0". The TBG.. and the TBS.. groups give information about the position of the MTB TIME/DIV switch.
The (L) and (F) inputs are only used in the PM 3263X (= TV version).

6.2.6.2. VOLTAGE CONTROLLED OSCILLATOR (V.C.O.)

The V.C.O. which is controlled by the SET knob R1 is used to adjust the following values:

- Delay time
- ΔT time
- Number of Events to be counted.

The V.C.O. consists of amplifier D2301-D.

V.C.O. "off"

With R1 (SET) in the mid-position the potentials on pt.5 and pt.9 of amplifiers D2301-A and D2301-B are equal. Combined with the potential adjusted by R2302 it results in both inputs of NAND-gate D2302-A being high, and consequently the output of D2302-B is high. This brings input 11 of D2301-D at a potential which is always higher than the voltage on input 10 of D2301-D. A stable situation is thus obtained (pt. 13 of D2301-D is logic 1).

V.C.O. "on"

As soon as R1 (SET) is rotated out- of the mid-position, one of the outputs of D2301-A or D2301-B goes to zero which results in the output of D2302-B going to logic 0.
Now the voltage on point 11 of D2301-D is lower than the voltage on point 10 and the output pt.13 of this amplifier goes to logic 0. Consequently, the output of D2302-D goes to logic 0 and capacitor C2303 is discharged via R2323.

At the moment that the voltage on pt. 10 of D2301-D is lower than the input voltage on pt.11, the output of D2301-D goes to logic 1. Now C2303 is charged via R2312 until the voltage on pt. 10 exceeds the voltage on pt.11 of D2301-D and the output of D2301-D goes to logic 0 again, and so on.
Note that C2303 is not charged via R2323 because D2302 is an open-collector circuit.
The further R1 is rotated from its mid-position the faster C2303 is loaded and the higher the V.C.O. frequency. The V.C.O. frequency is even more increased if R1 is far from the mid-position because V2301 then becomes conducting and R2316 comes in parallel with R2312.
Adjusting potentiometer R2321 influences the voltage-gap at the input of D2301-D and thus the frequency of the V.C.O.
When R1 is rotated only a few degrees out of its mid-position the V.C.O. frequency will be very low. For

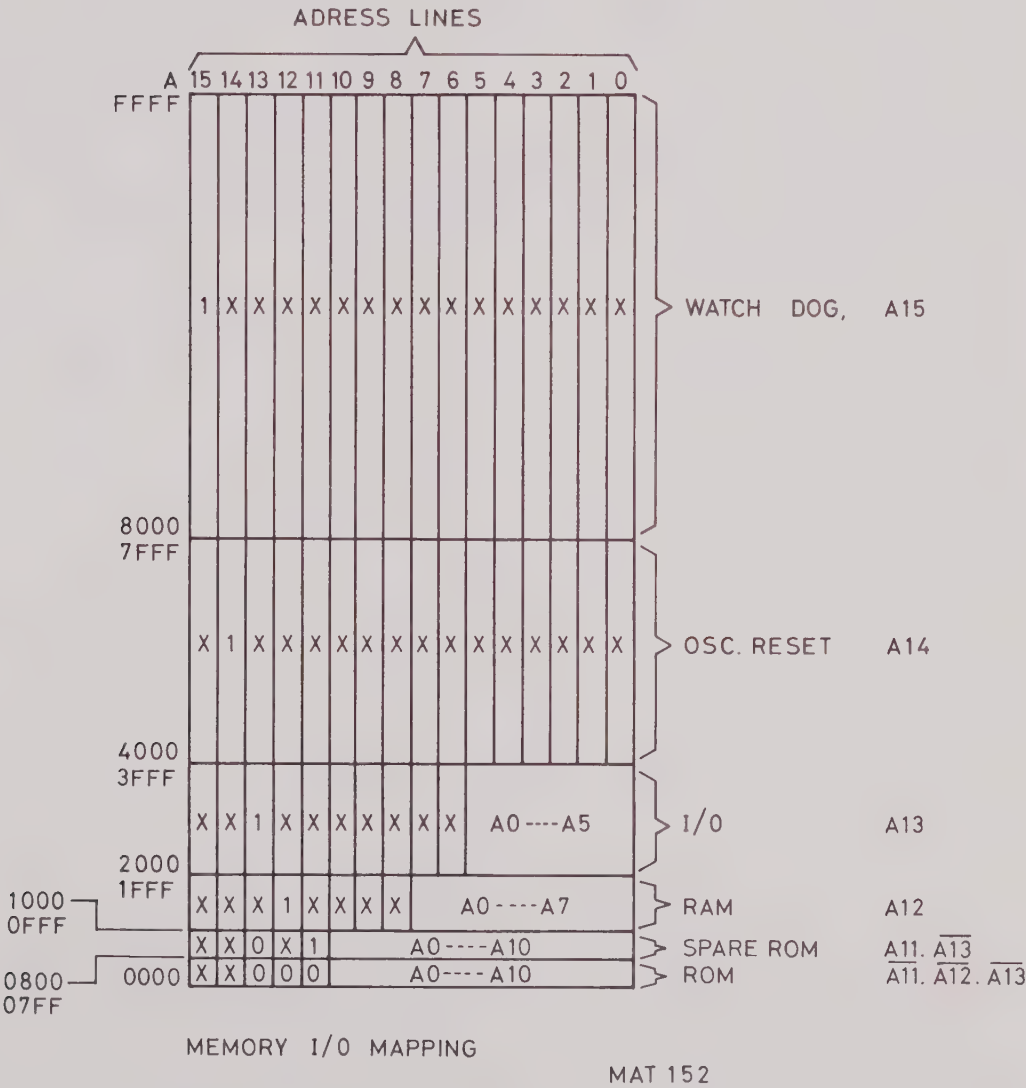


Fig. 6.11. Memory map

convenience of operation one V.C.O. pulse is generated as soon as R1 is rotated out-of its mid-position. As soon as the V.C.O. is switched-on the output of D2302-B jumps to logic 0, and via C2306 this appears as a negative pulse on input 11 of D2301-D. This results in one V.C.O. output pulse. R2306 provides D2301-D with a certain positive feed-back to avoid unstable situations during switching over. Note that if the SET knob is pushed (= frequency x100) nothing changes in the V.C.O. circuit. In this case the microprocessor gets the message to count in steps of hundreds in stead of ones.

Up/Down

The up-count, or down-count information is obtained with D2301-C. Both inputs of D2301-C are connected to the SET potentiometer.

6.2.6.3. EVENT COUNTER

The event counter allows the selection of the number of pulses that elapse before triggering (from 1 to 99999). This is achieved by using counters D2402, D2406, D2407, D2409 and D2411. Counter D2402 (ECL) is the LSB counter.

Briefly, it operates by putting the 9's complement of the selected event number into it. The counter is started and counts up until it reaches 99998. That means that it has counted all the events minus 1. At that moment, the triggering of the time-base is freed and the next pulse that is received triggers the time-base.

The 9's complement of the selected number of events is put into latches D2413-D2414-D2416-D2417 and D2418 by the microprocessor. Latches are selected by IOW and A0, A1 or A2.

The contents of the latches is only changed if the selected number of events has been modified (i.e. changing of the selected number of events cause an RST 6,5 interrupt to the microprocessor which modifies the contents of the latches).

The counters are preset by the latches at the beginning of the hold-off time after each time-base sweep.

Presetting the counters (Refer to Fig. 6.12.)

At the start of the hold-off period in D2404 a 200 ns pulse and a 100 ns pulse is generated, via V2401.

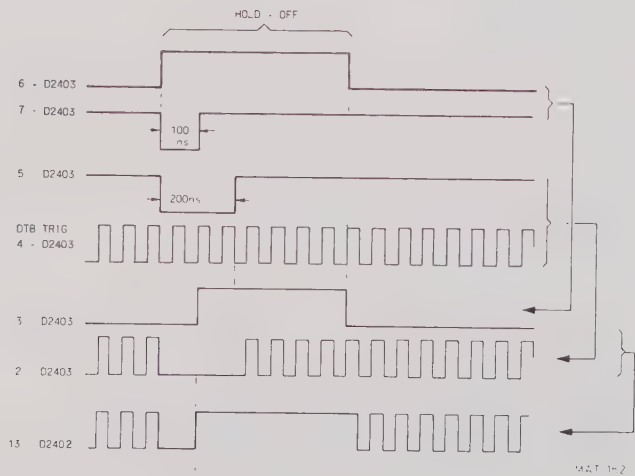


Fig. 6.12. Presetting the counters

The counters D2406, D2407, D2409 and D2411 are preset during the 200 ns pulse which is applied to the load input point 11 of these counters.
Counter D2402 receives the same 200 ns pulse (on its S2 input point 7) but requires during this pulse also a clock pulse (CL input point 13).
This clock pulse is the positive-going edge of the 100 ns pulse.

Counting

Counting is started on the first trigger pulse after the hold-off period of the main time-base.

The min./max. outputs of the counters (except D2402) will be at logic 1 when 99997 is reached. So via the AND gates D2408 a logic 1 is available on input 10 of NOR-gate D2419-A (output 14 will go to logic 0).

At the reset input point 4 of flip-flop D2401-B the count enable (logic 0) signal is present, coming from point 15 of flip-flop D2401-A.

As input 13 of OR-gate D2419-B is permanently at logic 0, and point 12 is now at logic 0, output point 9 will go to logic 0.

Point 3 of D2419-C is at logic 1 because counter D2402 has not yet reached the end of its count.

As soon as D2402 counts "8", the output point 3 of D2402 and also point 3 of NOR-gate D2419-C goes to logic 0.

Because of the wired- or function of D2419-A-B-C the COUNT READY signal which is applied to the time-base circuit is low as all 3 outputs 3, 9 and 14 are low.

On the eight pulse the COUNT READY signal will be at logic "0", but the counter D2402 continues counting and after two further pulses point 3 of D2402 will be at "0" and the counter goes back to zero to resume counting.

To retain the COUNT READY information, it is latched in flip-flop D2401-B via NOR-gate D2419-D.

The COUNT READY signal is inverted in by D2419-D to give a positive-going clock pulse to flip-flop D2401-B

The logic 1 on the preparatory input (point 7) of flip-flop D2401-B, gives a logic 1 on inputs 11 and 7 of

D2419, thus the COUNT READY signal is retained.

After the sweep of the MTB, the flip-flop D2401-A is reset and the logic 0 signal COUNT ENABLE resets the flip-flop D2401-B.

The coupling of the first counter D2402 to the second one D2406, goes via the diodes V2403, V2406 and transistor V2407.

The circuit with V2403 and V2406 is used to provide a wider clockpulse for the next counter.

Transistor V2407 matches the ECL circuit D2402 to the TTL circuit D2406.

6.2.6.4. DISPLAY UNIT

The display unit indicates the selected delays on numbers of events before triggering. It comprises six 7-segment numerical LED displays and three LED's for EEvent, DIVision and Sec or Hz.

Access to the individual digits by the microprocessor is achieved by the binary-decimal latch D2203. A T2 signal derived from IOW and address line A6 is send to the input E point 14 of D2203 and all eight output bits can be accessed by the relevant choice of data combination.

In turn the logic ones at the outputs 4, 5, 6, 7, 9, 10, 11 and 12 of D2203 cause the related drive transistor (V2221 to V2228) to conduct and connect the cathode of the display to the 0 V line. Only one latch is activated at a time, therefore only one cathode of the display is activated at a time. This provision is necessary because the segment information is present on all display digits.

Point 15 of D2203 gets +5 V via an RC filter R2218, C2204, which blanks the LED display during the very first moment of power-on.

In order to illuminate the appropriate display, anode currents must flow in the selected segments of the digit activated. All segments of the display are connected to a current source comprising eight transistors, V2211 to V2219 (7-segments +1 decimal point). These current sources are permanently on because of the current applied to their bases. The currents flow either into the connected segments of the selected display or into the switching transistors V2201 to V2209, that can be selected to conduct by the latches D2201 and D2202. Digit information is offered via the data bus lines D0 ... D7 to the latches D2201 and D2202. The information is taken over by the latches with the T1 signal which is derived from IOW and address line A5.

In this way, when a digit is selected for illumination by D2203; i.e. its cathode is connected to 0 V, the segment information from D2201 and D2202 causes the constant current to flow in the segments selected (by blocking the relevant drain transistors). The segments not selected for illumination are effectively by-passed as the constant current still flows in the remaining drain transistors. As each constant current flows through either a segment or a transistor the current drain remains the same irrespective of the number of segments illuminated.

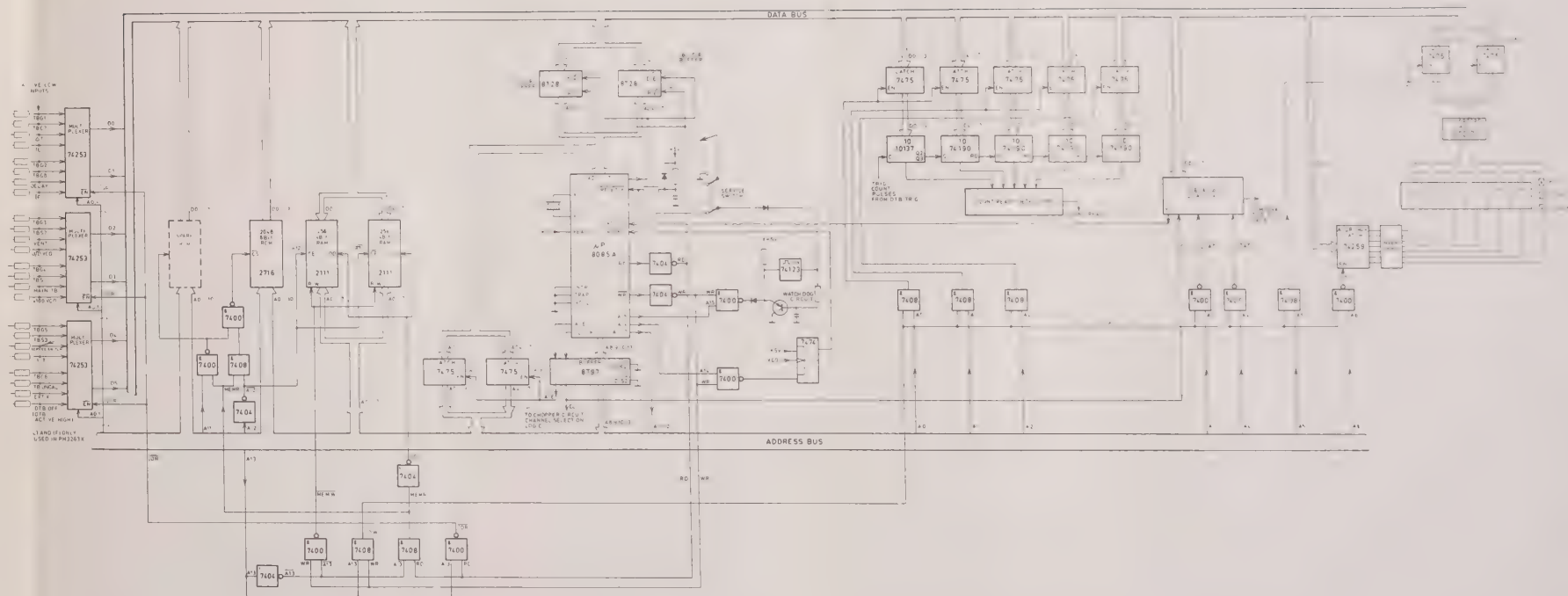


Fig. 6.10. Blockdiagram microprocessor and circuits which are under control of the microprocessor

6.2.7. X deflection selector and alternate time-base logic

Depending on the selected position of X deflection source selector switch S2, the circuit provides for X deflection by the main time-base signal, the delayed time-base signal, a signal from an external source or X deflection by one of the internal signals derived from channel A, channel B or the mains voltage. There is also the possibility to select the main and delayed time-bases alternately.

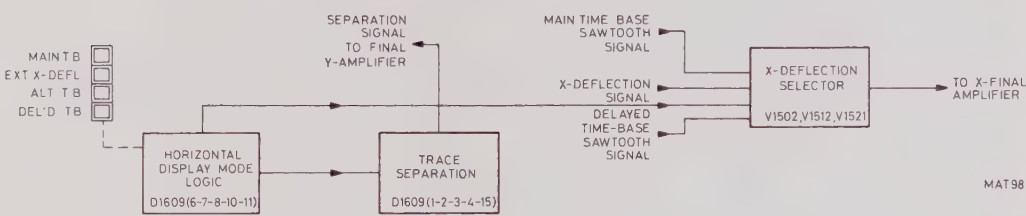


Fig. 6.13. X deflection selector and alternate time-base logic.

The different functions of the logic circuits are now described according to the horizontal display mode selector switch S2:

MTB

- When no pushbutton is depressed or when MTB is depressed flip-flop D1609 is set in the MTB position via its R and S inputs (output 10 is high).
The MTB pushbutton releases all the other push-buttons of the horizontal deflection mode selector, its contacts are not used.
In the MTB position of switch S2, transistor V1509, which is driven by output 10 of flip-flop D1609, and consequently transistor V1511, conduct. Diode gate V1513, V1514 is therefore opened and the main time-base output is applied via transistor V1512 to the X amplifier, via these diodes and R1703.
In this mode only the main time-base sawtooth signal is fed to the X final amplifier and not the delayed time-base sawtooth signal and the X-deflection signal.

DTB

- With DTB selected flip-flop D1609 is set to the DTB state via its S and R inputs (output 11 is high).
In the DTB position of switch S2, transistor V1501, driven by output 11 of flip-flop D1609 and consequently transistor V1506 are conducting. The diodes V1503 and V1504 conduct and provide a signal path for the output sawtooth signal of the delayed time-base generator to the X final amplifier. With DTB selected the main time-base signal and the X deflection signal are blocked.

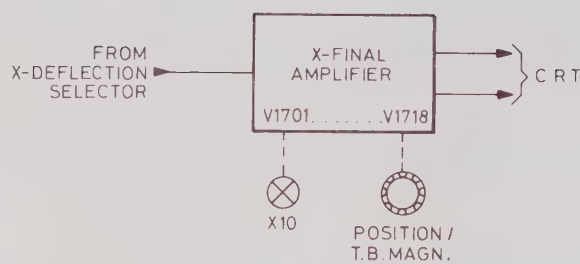
EXT X DEFL

- In the EXT X DEFL position a +5,2 V is applied via switch S2 to the base of V1516, with a result that the base of V1517 exceeds +5,2 V and this transistor is turned off.
Transistor V1524 then starts to conduct via R1528 and diode V1523 (8,2 V), and the external signal for amplifier V 1519, V1520 and V 1521 is routed via the diode gate V 1522, V 1526 to the X amplifier.
When EXT X DEFL is switched off, transistor V1516 is turned off and transistor V1517 conducts via R1522. The collector of V1517 is therefore at +5,2 V, and as the voltage across diode V1523 is less than 8,2 V, this diode is blocked and transistor V1524 is turned off. In this position the X MAGN reed relay K1701 for the X1, X10, may be switched in. This is not operative when EXT X DEFL is switched on.

ALT TB

- With ALT TB depressed, the oscilloscope is set in the alternate time-base mode and the main and delayed time-bases are selected alternately.
ALT TB is not possible with DTB TIME/DIV switch S13 in the "OFF" position and with push-button TRIG VIEW of switch S1 depressed.
Switching over from MTB to DTB in ALT TB mode is achieved by switching in transistor V1509 and V1501 in turn via flip-flop D1609.
In ALT TB a +5 V signal is fed to input 4 of NAND D1606. With the delayed time-base switched off and with TRIG VIEW not depressed a 0 V signal appears at output 6 of NAND D1606. With this 0 V signal NAND D1608 (11-12-13) is blocked and flip-flop D1609 is set for normal switching by its clockpulse input signal. There is no longer a signal path for the alternate signal from the time-base generator to the vertical display logic other than via flip-flop D1609, NAND 1608 (8-9-10) and NAND D1607 (8-9-10).
The flip-flop output signal is also applied to R632 in the trace separation circuit to control the vertical space between the two time-base displays.

6.2.8. X Final amplifier



MAT99

Fig. 6.14. Final X amplifier

The final X amplifier consists of two identical amplifier stages in parallel (one for each deflection plate). One stage consists of transistors V1706, V1707, V1708 and V1709 and the other consists of transistors V1714, V1716, V1717 and V1718.

The final stage is supplied from the +60 V and -60 V because the X plates of the C.R.T. are mechanically displaced such that they are less sensitive than the Y plates.

The amplifier stages are controlled via the transistors V1701 and V1702.

With the X POSITION potentiometer R2 the bias of transistor V1702 can be varied. Potentiometer R2 consists of a tandem potentiometer with back-lash, giving a nice vernier control. Variation of the bias causes the balance of the amplifier to be disturbed, which results in a horizontal trace shift on the screen.

The X amplifier allows choice from X deflection by the time-base signals or one of the sources, channel A, channel B, line or an external signal. The X deflection source is selected with the aid of X deflection mode selector switch S2 and the X deflection source selector switch S22.

The selected X deflection signal is applied via R1703 to the base of transistor V1701.

The X amplifier offers the possibility of using either the nominal gain (X1 position of X MAGN switch S3), or the gain increased by a factor of 10 (X10 position of the X MAGN switch S3).

When the front-panel X MAGN switch S3 is operated for X10 magnification, the emitter resistance of V1701 and V1702 is shunted by resistors R1704, R1706 and R1707 via relay K1701, reducing the value by a factor of 10. Consequently, the gain of the stage is increased by the same factor.

The X1 gain can be set by potentiometer R1709 and the gain X10 by potentiometer R1706. The gain X10 is not operative when EXT X DEFL is selected.

Both outputs of the X final amplifier are connected to the X deflection plates of the C.R.T.

For correct orthogonality adjustment a signal from the orthogonality potentiometer R1737 is applied to R661 in the final Y amplifier.

6.2.9. Cathode-ray tube circuit

The cathode-ray tube circuit comprises the C.R.T. itself and the brightness, focus, astigmatism, geometry and trace rotation controls and the beam blanking amplifier. A block diagram of the C.R.T. circuit is given in fig. 6.15.

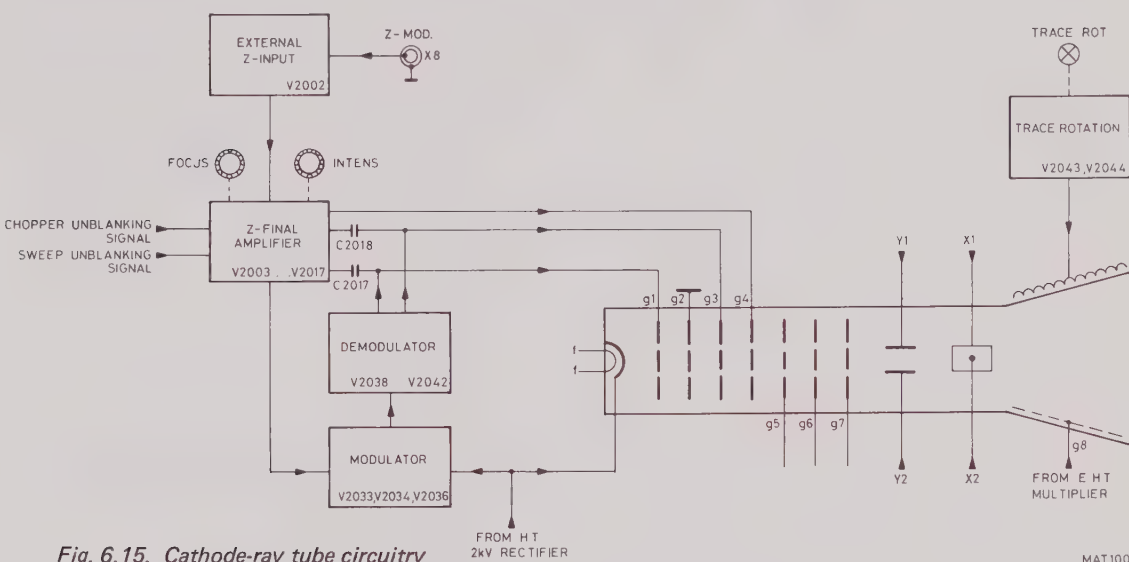


Fig. 6.15. Cathode-ray tube circuitry

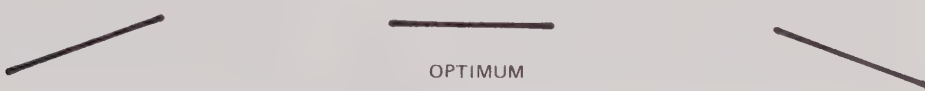
6.2.9.1. C.R.T. controls

By means of the INTENS potentiometer R16, the brightness of the display can be continuously controlled. The display can be focused by means of the FOCUS potentiometer R17. Both INTENS and FOCUS controls are front panel controls.

Furthermore the C.R.T. circuitry comprises preset potentiometers for trace rotation, astigmatism and geometry.

The FOCUS control R17 forms a part of a voltage divider network across the 2 kV output of the power supply.

TRACE ROTATION is achieved by means of the trace rotation coil. This coil mounted inside the mu-metal screen, provides a magnetic field for rotational control of the entire scan. The degree and direction of rotation is determined by the setting of front panel potentiometer R15 (screwdriver operated). The slider of R15 is connected to the bases of the complementary transistors V2043 and V2044. The trace rotation coil is supplied by these transistors.



With the ASTIGMATISM control R2037, the form of the spot can be adjusted by influencing the voltage on grid G4.



With the GEOMETRY control R2039 the barrel and pin-cushion distortion is corrected by influencing the voltage on the grid G6.



6.2.9.2. Z unit and Focus unit

In these units, the controls for the following c.r.t. grids are located:

- G1 Wehnelt cylinder controlled between -2200 V and -2300 V
- G2 Screen grid at earth potential
- G3 Focusing grid, at approximately $-1000\text{ V} \dots -1100\text{ V}$
- G4 Astigmatism grid at $\pm 30\text{ V}$ (adjustable from -60 V to $+60\text{ V}$).

Focus and modulation

To maintain a well-focused spot, independent of the beam current, the voltage pulse is applied to the focusing grid G3. This pulse is in antiphase with, and has an amplitude of approximately 60 % of the Z pulse on G1. The phase shift is achieved by differential stage V2006, V2011. This stage is followed by individual driver stages for G1 and G3.

The a.c. pulse is applied to grids G1 and G3 via capacitors C2017 and C2018 respectively.

The d.c. transfer is obtained by means of an oscillator, driven via R2064 and R2067, and a demodulator working at e.h.t. level. The oscillator pulses are transferred via C2038 and C2039 to be demodulated by diodes V2038 and V2039 (positive components) and by diodes V2041 and V2042 (negative components). The a.c. and d.c. paths of G3 are equalised by the voltage divider R2083, R2084.

Z-unit

The Z-amplifier has the following inputs:

- via the INTENS potentiometer R16.
- the external input socket X8 (Z-mod.).
- two signals originating in the main and delayed time-bases are applied to the amplifier to unblank the trace during the sweeps.
- the chopper blanking pulse to blank the trace during switching from channel to channel in the chopped mode.

The bright-up pulse of the main and delayed time-base is obtained in a similar way. In the main time-base, the pulse that switches V907 is also used for switching on and off transistor V903 and diode V904. Diode V904 is conductive when the time-base is running and in that case consumes about 3 mA from the switching unit. When V904 is blocked (during the hold-off time) a current (Z pulse) flows via V902 to R1542 in the Z-unit. This current is consumed by V904 when this diode is conductive.

The same conditions apply to the delayed time-base. When the position DEL'D TB is selected, transistor V1527 on the switching unit is turned off and resistor R1539 feeds 3 mA into the Z amplifier unit, which during the delayed time-base sweep is consumed via R1534 by V1307.

The sequence is as follows:

- start MTB, start DTB; less than 3 mA = half intensity.
- then start DTB; end of DTB; 0 mA = brilliance (bright-up pulse)
- then end DTB, end MTB; less than 3 mA = half intensity
- end MTB, start MTB; more than 3 mA = blanked pulse.

During the hold-off period, 3 mA is applied via V1528. The trace is then blanked regardless of any other control signals. This applies to the chopper blanking circuit, which supplies current pulses of 3 mA, via R1609. Resistor R2001 also supplies 3 mA, which can be bypassed by transistor V2003 as determined by the position of the INTENS potentiometer R16. This provides a continuous control of the trace brilliance. Finally, the external input pulse may take over the current of transistor V2003 via V2002, independent of the set brilliance. As a result of the current flowing through R2001, the c.r.t. is blanked. The sensitivity of the external Z input is adapted to suit TTL logic. Logic "1" provides blanking; logic "0" is ineffective.

6.2.9.3. CRT cathode regulation

To prevent sensitivity variations of the c.r.t., the cathode voltage is regulated. Variations of the a.c. supply voltage are applied via C2028 to an amplifier consisting of V2026, V2024 and V2023; d.c. variations are applied via R2051. The collector voltage of V2023 compensates for the voltage variations of the power supply and the rectifier. Consequently, the cathode voltage remains independent of the cathode current.

6.2.10. Power supply

The power supply comprises a mains transformer and rectifier, a DC to AC converter regulator and a transformer and output voltage rectifier

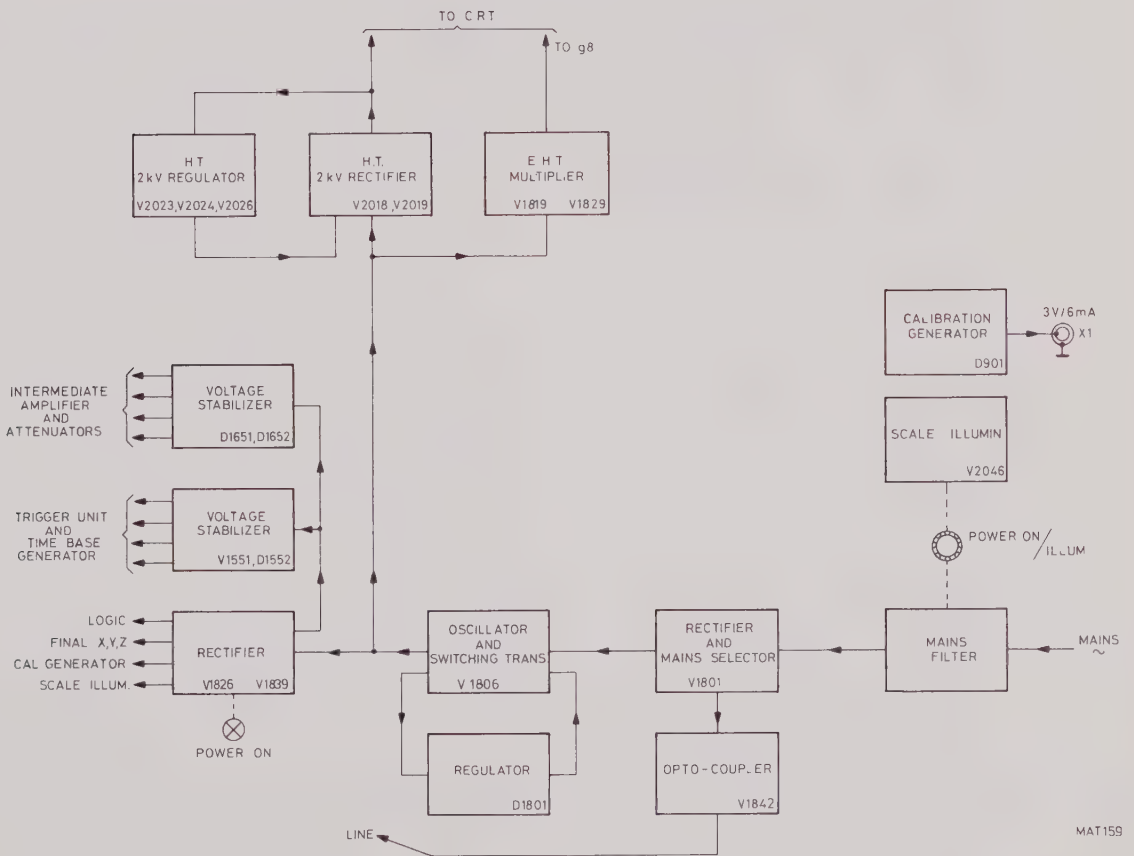


Fig. 6.16. Power supply

Input circuit

The power supply input circuit is matched to the 115 V or 230 V range with selector-switch S1801 which is located at the power supply unit at the rear side.

The mains voltage is rectified with the diode bridge V1801 and C1802, C1803, which form a voltage doubler in the 115 V position of S1801, and a standard bridge rectifier circuit in the 230 V position of S1801.

The voltage across the series circuit of C1802 and C1803 amounts 250 V to 400 V for both mains voltage ranges.

Switching circuit

The unregulated d.c. voltage is applied in the form of pulses to a resonance circuit consisting of the primary coil of the converter transformer T1801, combined with C1807 and C1808, via switching transistor V1806. The sine-wave voltage (approx. 800 Vp-p) across the primary coil of T1801 is kept constant by regulating the duty cycle of the base current of V1806.

The primary coil of L1806 which is in series with the switching transistor, limits the current through this transistor.

The energy stored in L1806 is fed-back to the mains rectifier circuit, during the cut-off time of V1806, via diode V1811.

V1808 and V1809 keep the dissipation during the switching moments out of transistor V1806; instead of these losses are dissipated in R1814 and R1816.

V1807 improves the base drive for V1806.

Regulator circuit

The regulator circuit itself consists of integrated circuit D1801 (type TDA 1060), the output (p.15) of which supplies a square wave current with variable duty-cycle to the base of V1812.

The duty-cycle of this signal is variable.

The collector signal of V1812 is applied to the switching transistor via transformer L1803.

The regulator circuit is controlled by:

- Feed-back voltage (p.3)
This is the regulator control voltage and is taken from the rectifier circuit at the feed-back winding of T1801.
This control voltage depends on the setting of R1826 (V out).
- Feed forward (p.16)
This voltage is derived from the mains voltage and provides direct mains voltage variation compensation.
- Over-voltage protection (p.13)
This voltage is also derived from the mains voltage and inhibits the regulator output at too high mains voltages (the trip-level on p.13 is 600 mV).
- Current limit (p.11)
The voltage drop across the current-sense resistor R1811 controls the regulator circuit in case of overload.
- Frequency (p.7)
The resistance between p.7 and gnd estimates the converter frequency.
R1827 (Freq.) has been adjusted to obtain a frequency of 20 kHz.
The resonance frequency of C1807, 1808 and the primary coil of T1801 is wide enough to tolerate this.

Under normal working conditions the power supply voltages for the regulator circuit are delivered by the rectifier connected to the feed-back winding of T1801.

V1804 is then conducting so that V1803 does not deliver current.

Switching-on

When switching-on the instrument, no supply voltages are available in the regulator circuit, from T1801.

At this moment V1804 is not conducting, so that V1803 is fully conducting, and the regulator circuit gets current via R1804 and R1806.

As soon as the converter circuit is working V1804 becomes conducting and V1803 is not conducting anymore.

Switching-on protection

If the instrument is switched-on and no convertor voltage would appear (due to a possible defect) the PTC resistor R1806 will warm up, reducing the current through V1803 to a safe low value.

Output circuits

The output rectifiers are of the coil-input types delivering the mean value of the sine-wave transformer voltages across the output capacitor.

Except the d.c. voltages the convertor transformer delivers also:

- 6,3 V for the c.r.t heater
- 0-1 kV - 1,5 kV for the focus and high tension circuits
- 120 V for the additional power supply unit.

Photocoupler circuit

This circuit delivers a sine-wave voltage (derived from the mains voltage) used for mains triggering or mains deflection.

The photo-coupler V1842 which provides isolation between the mains voltage and the oscilloscope's circuitry drives the V1843-circuit in saturation, so that the square-wave voltage at the collector of V1843 has the same value for all mains voltages.

With an integration network R1851, 1852, 1853 and C1836, 1837, 1838 the original sine-wave is obtained. Via V1844 and V1846 this signal is applied to the trigger selector (R730) via capacitor C1839.

6.2.11. Additional power supply

This unit delivers supply voltages for:

- the microprocessor circuit
- the event counter (partly +5,2 V)
- the LED display circuit.

120 V a.c. (≈ 20 kHz) from the power supply unit is applied to the primary coil of transformer T1876.

The secondary rectifier circuits deliver +5 V and +6 V.

The +5,2 V supply voltage for the event-counter ECL circuits is made by V1883 and D1876. The +5,2 V reference voltage for D1876 is taken from the time-base circuit.

6.2.12. Illumination circuit

The graticule of the C.R.T. can be illuminated by means of the bulbs E1 and E2. The intensity can be varied with the aid of ILLUM potentiometer R14 which controls the collector current (which is the current through the bulbs) of transistor V2046. The illumination circuit is not short-circuit proof.

6.2.13. Calibration circuit

The calibration unit is a square-wave generator consisting of an operational amplifier D1901 with feedback. The oscillator frequency is determined by resistor R1909 and capacitor C1903. Capacitor C1902 keeps point 3 of the IC constantly equal to the average output voltage. Consequently, the generator is independent of fluctuations in the supply voltage.

The square-wave amplitude is determined by zenerdiode V1901.

Potentiometer R1906 allows accurate adjustment of the output voltage and output current.

This output voltage is fed to socket x1 and the output current flows through current loop x2. This is the front panel CAL terminal.

The calibrator output signal can be used for probe compensation and/or checking the vertical deflection accuracy.

7. DISMANTLING THE INSTRUMENT

7.1. WARNING

The opening of covers or removal of parts, except those of which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.

The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the instrument will be opened.

If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the hazard involved.

Bear in mind that capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

7.2. REMOVING THE COVERS AND SCREEN BEZEL

Both upper and lower cabinet plate can be removed after slackening one or two turns the four quick-release fasteners at the corners of each plate. Do not slacken the fasteners more than two turns, otherwise they may come apart.

The screen bezel can be detached by pressing the longer edges and pulling it out the front panel.

7.3. ACCESS TO PARTS NECESSARY FOR CHECKING AND ADJUSTING

Most of the adjustment points can be reached after removal of the top and bottom covers of the instrument (see section 9).

However at the bottom side the Z-amplifier (unit 11), focus unit (unit 7) and EHT multiplier (unit 15) are covered by a black metal screening plate. This plate is provided with holes that align with adjustment points on the Z-amplifier and the output voltage adjustment point of the power supply (R1826/unit 5).

For adjustment, always use an *insulated adjustment tool*.

If it is necessary to reach resistors on the Z-amplifier for measuring or adjustment purposes, the screening plate can be removed after slackening four screws.

Warning: note that after removal of this cover parts are accessible that carry dangerously high voltages.

8. CHECKING AND ADJUSTING

WARNING

The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.

The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the instrument will be opened.

If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the hazard involved.

Bear in mind that capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

8.1. GENERAL INFORMATION

8.1.1. Introduction

The following information provides the complete checking and adjusting procedure for the oscilloscope. As various control functions are interdependent, a certain order of adjustment is often necessary.

The procedure is, therefore, presented in a sequence that is best suited to this order.

Before any check or adjustment, the instrument must attain its normal operating temperature.

- Where possible, instrument performance is checked before an adjustment is made.
- Warming-up time under average conditions is 30 minutes.
- All limits and tolerances given in this section are calibration guides and should not be interpreted as instrument specifications unless they are also published in section 1.2. characteristics.
- Tolerances given are for the instrument under test and do not include test equipment error.
- The most accurate display adjustments are made with a stable, well-focused, low-intensity display.
- Unless otherwise noted, adjust the Intensity, Astigmatism, Focus, and Trigger Level controls as needed.

8.1.2. Recommended test equipment

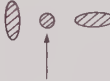
Required instrument	Specifications	Example of required instrument
Square-wave generator	1 Hz – 50 MHz Constant amplitude of 10 mV – 30 V, rise-time ≤ 1n sec duty cycle 50%	–
Sine-wave generator	1 Hz – 100 MHz Constant amplitude of 10 mV – 30 V	–
Time mark generator	1 sec. –50 n.sec in 23 calibrated positions in a 1-2-5 sequence	–
Digital multimeter	Wide voltage, current and resistance ranges	Philips PM 2527
Variable mains transformer	180 V – 265 V ~	Philips 2422 529 00005
Oscilloscope	100 MHz	Philips PM 3240
Dummy probe	2:1, R = 1 MΩ, C = 15 pF	see Fig. 5.6.
Low capacitance trimming tools		Philips 800NTX
High tension probe	Voltage range min 2500 V input resistance min 100 MΩ	Philips 9246 A

8.1.3. Preliminary settings of all the controls

All preset potentiometers and trimming capacitors are indicated on the drawings of the printed-wiring board, see the figures

- Push the Y POSITION controls to the depressed position
- Set the switches of the channel A, B, C and D signal coupling controls to DC
- Set the DELAY TIME control (R3) to 0 (fully anti-clockwise)
- Depress push-button MAIN TB of the X-deflection controls (S8)
- Push the TB MAGN control to position X1.
- Depress push-button AUTO of the trigger mode controls
- Set the MAIN TIME/DIV switch to 1 ms
- Set the DEL'D TIME/DIV switch to OFF
- Set the TIME/DIV vernier controls to CAL
- Depress push-buttons A of the trigger-source controls (S29, S30)
- Select the DC trigger coupling mode (R25/R24/S32 depressed)

8.2. SURVEY OF ADJUSTING ELEMENTS

Adjusting and adjustment sequence	Adjusting element	Measuring values and explanation	Measuring instrument	Chapter	Figures
8.2.1. Power supply					
Power consumption	—	60 Watt	Moving iron meter	8.3.1.1.	—
+12,7 Volt supply voltage	R1826/unit 5	+12,7 V $\pm$ 100 mV	Digital multimeter	8.3.1.2.	8.7./11.4.
Oscillator frequency	R1827/unit 5	+12,7 V $\pm$ 100 mV	Digital multimeter	8.3.1.3.	11.4.
Supply voltages unit 12	R1654/unit 12	+11,4 V	Digital multimeter	8.3.1.4.	8.7./11.9.
	R1673/unit 12	−11,4 V	Digital multimeter	8.3.1.4.	8.7./11.9.
Cathode voltage	R2048/unit 11	2150 V $\pm$ 1%	Digital multimeter + High tension probe	8.3.1.5.	8.7./11.8.
8.2.2. Calibration generator					
Cal. voltage	R1906/unit 17	3 V $\pm$ 1%	Oscilloscope	8.3.2.	8.7.
Cal. frequency	—	2 kHz $\pm$ 2%	Oscilloscope	8.3.2.	—
8.2.3. C.R.T. - Circuit					
Astigmatism	R2037/unit 11		—	8.3.3.1.	8.7.
Focus	R2074/unit 11	Optimal shape of the spot	Sine-wave generator	8.3.3.1.	8.7.
Trace rotation	R15/front panel	Mid position of focus potentiometer	—	8.3.3.2.	—
Orthogonality	R1737/unit 26	 Adjust for horizontal trace	Sine-wave generator	8.3.3.3.	8.2./8.8.
Geometry	R2039/unit 26	—	Sine-wave generator	8.3.3.4.	8.3./8.8.
		 Adjust for minimal barrel and pin-cushion distortion			
Intensity	R2071/unit 11	Barely visible dot at the beginning of the trace	—	8.3.3.5.	8.7.
Intensity ratio	R2012/unit 11	20 μ V across R2087	Digital voltmeter	8.3.3.5.	8.7./11.8.
	R1537/unit 8	Barely visible MTB trace and DTB trace more brilliant	Sine-wave generator	8.3.3.6.	8.4./8.8.
8.2.4. Balance adjustments					
0-DC balance	R124/Ch.A/unit 2	Minimum trace jump when switching 0-DC	—	8.3.4.1.	8.7.
	R174/Ch.B/unit 2	Minimum trace jump when switching 0-DC	—	8.3.4.1.	8.7.
Attenuator balance	R129/Ch.A/unit 2	Minimum trace jump when switching 5 V - 10 mV/DIV	—	8.3.4.2.	8.7.
	R179/Ch.B/unit 2	Minimum trace jump when switching 5 V - 10 mV/DIV	—	8.3.4.2.	8.7.
Continue balance	R211/Ch.A/unit 12	Minimum trace shift when turning the continuous control	—	8.3.4.3.	8.7.
	R311/Ch.B/unit 12	Minimum trace shift when turning the continuous control	—	8.3.4.3.	8.7.
Balance 5 mV/DIV	R216/Ch.A/unit 12	Minimum trace jump when switching 5 mV - 10 mV/DIV	—	8.3.4.4.	8.7.
	R316/Ch.B/unit 12	Minimum trace jump when switching 5 mV - 10 mV/DIV	—	8.3.4.4.	8.7.
Polarity (normal/ invert) balance	R259/Ch.A/unit 12	Minimum trace jump when switching Normal - Invert	—	8.3.4.5.	8.7.
	R359/Ch.B/unit 12	Minimum trace jump when switching Normal - Invert	—	8.3.4.5.	8.7.
Trigger balance M.T.B.	R881/unit 9	Starting point of trace may not change when operating the +/-SLOPE switch	Sine-wave generator	8.3.4.6.	8.8.
	R835/unit 9	—	Sine-wave generator	8.3.4.6.	8.8.
	R431/unit 12	Trace must remain in the screen centre	—	8.3.4.6.	8.7.
	R481/unit 12	Trace must remain in the screen centre	—	8.3.4.6.	8.7.
	R729/unit 16	Trace must remain in the screen centre	—	8.3.4.6.	8.7.
	R527/unit 12	Starting point to central horizontal graticule line	Sine-wave generator	8.3.4.6.	8.7.
	R1523/unit 8	Point to central vertical graticule line	—	8.3.4.6.	8.8.
	R737/unit 16	Point to first vertical graticule line	—	8.3.4.6.	8.7.
Trigger balance D.T.B.	R1235/unit 9	DTB level adjustment	—	8.3.4.7.	8.8.
	R1268/unit 9	Starting point trace may not change when operating the +/- SLOPE switch	Sine-wave generator	8.3.4.7.	8.8.
	R428/unit 12	Starting point in the screen centre	Sine-wave generator	8.3.4.7.	8.7.
	R478/unit 12	Starting point in the screen centre	Sine-wave generator	8.3.4.7.	8.7.
Y-position correction and added mode balance	R658/unit 13	Trace exactly in screen centre	—	8.3.4.8.	8.8.
	R500/unit 12	Trace exactly in screen centre	—	8.3.4.8.	8.7.
	R500/unit 12	Minimum trace jump when switching between ALT and ADD	—	8.3.4.8.	8.7.
Time base magnifier balance	R1749/unit 26	No movement of starting point of trace when operating the MAGN control	—	8.3.4.9.	8.8.

8.2.5. Time base generators

Adjusting and adjustment sequence	Adjusting element	Measuring values and explanation	Measuring instrument	Chapter	Figures
MTB time coefficients	R1709/unit 26	1 ms/DIV range	Time-marker generator	8.3.5.1.	8.8.
	R913/unit 8	5 ms/DIV range	Time-marker generator	8.3.5.1.	8.8.
	R911/unit 8	1 μ s/DIV range	Time-marker generator	8.3.5.1.	8.8.
	R1706/unit 26	Time base magnifier	Time-marker generator	8.3.5.1.	8.8.
	C916/unit 8	0,1 μ s/DIV range	Time-marker generator	8.3.5.1.	8.8.
DTB time coefficients	R1326/unit 8	1 ms/DIV range	Time-marker generator	8.3.5.2.	8.8.
	R1318/unit 8	5 ms/DIV range	Time-marker generator	8.3.5.2.	8.8.
	R1321/unit 8	1 μ s/DIV range	Time-marker generator	8.3.5.2.	8.8.
	C1311/unit 8	0,1 μ s/DIV range	Time-marker generator	8.3.5.2.	8.8.
	R2313/unit 23	Adjust for symmetrical behaviour of SET control R1	—	8.3.5.3.	8.1./8.8.
VCO adjustment	R2302/unit 23	Adjust for sufficient STOP range of SET control R1	—	8.3.5.3.	8.1./8.8.
Dual DAC adjustment	R2321/unit 23	Frequency adjustment of VCO	—	8.3.5.3.	8.8.
	R2602/unit 9	START adjustment of DELAY mode	Time-marker generator	8.3.5.4.	8.8.
	R2606/unit 9	STOP adjustment of DELAY mode	Time-marker generator	8.3.5.4.	8.8.
	R2613/unit 9	START adjustment of Δ T mode	Time-marker generator	8.3.5.4.	8.8.
	R2626/unit 9	EQUALity adjustment of Δ T mode	Time-marker generator	8.3.5.4.	8.8.
	R2617/unit 9	STOP adjustment of Δ T mode	Time-marker generator	8.3.5.4.	8.8.
	R6/front panel	R6 fully counter clockwise: distance between MTB and DTB traces 0 DIV R6 fully clockwise: distance between MTB and DTB traces 4 DIV	—	8.3.5.5.	—
Alternate time base and trace separation					

8.2.6. Sensitivities and LF corrections

LF correction of amplifier	R132/Ch.A/unit 2	Adjust for a straight pulse top	Square-wave generator	8.3.6.1.	8.7.
	R182/Ch.B/unit 2	Adjust for a straight pulse top	Square-wave generator	8.3.6.1.	8.7.
LF correction MTB	R736/unit 16	Adjust for a straight pulse top	Square-wave generator	8.3.6.2.	8.7.
external input					
LF correction DTB	R1118/unit 16	Adjust for a straight pulse top	Square-wave generator	8.3.6.3.	8.7.
external input					
Gain Y_A via Y	R654/unit 13	Adjust for a trace height of 6 DIV	Square-wave generator	8.3.6.4.	8.8.
Gain Y_B via Y	R13/front panel	Adjust for a trace height of 6 DIV	Square-wave generator	8.3.6.5.	—
Gain external X-deflection	R742/unit 16	Adjust for a trace height of 6 DIV	Square-wave generator	8.3.6.6.	8.7.
Gain external triggering via trig view	R842/unit 9	Adjust for a trace height of 6 DIV	Square-wave generator	8.3.6.7.	8.8.
Gain Y_A trig. view	R413/unit 12	Adjust for a trace height of 6 DIV	Square-wave generator	8.3.6.8.	8.7.
Gain Y_B trig. view	R463/unit 12	Adjust for a trace height of 6 DIV	Square-wave generator	8.3.6.9.	8.7.
Gain Y_A via X	—	Check for a trace height of 6 DIV $\pm$ 6,3 DIV	Square-wave generator	8.3.6.10.	—
Gain Y_B via X	—	Check for a trace height of 6 DIV $\pm$ 0,3 DIV	Square-wave generator	8.3.6.11.	—

8.2.7. Vertical channels

Square-wave response of attenuator unit	C107/Ch.A/unit 2	Check that pulse top errors do not exceed $\pm$ 3%	Square-wave generator	8.3.7.1.	8.7.
	C157/Ch.B/unit 2	Check that pulse top errors do not exceed $\pm$ 3%	Square-wave generator	8.3.7.1.	8.7.
	C112/Ch.A/unit 2	Check that pulse top errors do not exceed $\pm$ 3%	Square-wave generator	8.3.7.1.	8.7.
	C162/Ch.B/unit 2	Check that pulse top errors do not exceed $\pm$ 3%	Square-wave generator	8.3.7.1.	8.7.
Input capacitance of attenuator unit	C101/Ch.A/unit 2	Check that pulse top errors do not exceed $\pm$ 3%	Square-wave generator and 2:1 dummy probe	8.3.7.2.	8.5./8.7.
	C151/Ch.B/unit 2	Check that pulse top errors do not exceed $\pm$ 3%	Square-wave generator and 2:1 dummy probe	8.3.7.2.	8.5./8.7.
	C104/Ch.A/unit 2	Check that pulse top errors do not exceed $\pm$ 3%	Square-wave generator and 2:1 dummy probe	8.3.7.2.	8.5./8.7.
	C154/Ch.B/unit 2	Check that pulse top errors do not exceed $\pm$ 3%	Square-wave generator and 2:1 dummy probe	8.3.7.2.	8.5./8.7.
	C109/Ch.A/unit 2	Check that pulse top errors do not exceed $\pm$ 3%	Square-wave generator and 2:1 dummy probe	8.3.7.2.	8.5./8.7.
	C159/Ch.B/unit 2	Check that pulse top errors do not exceed $\pm$ 3%	Square-wave generator and 2:1 dummy probe	8.3.7.2.	8.5./8.7.
Square-wave response final Y amplifier	R634/C613/unit 13	Adjust for optimal square-wave response	Square-wave generator	8.3.7.3.	8.8./11.9.
Square-wave response channel A	R636/C614/unit 13	Adjust for optimal square-wave response	Square-wave generator	8.3.7.3.	8.8./11.9.
	R257/C229/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.4.	8.7./11.9.
	R253/C227/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.4.	8.7./11.9.
	R254/C228/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.4.	8.7./11.9.
	R244/C224/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.4.	8.7./11.9.
	C233/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.4.	8.7./11.9.
	C616/unit 13	Adjust for optimal square-wave response	Square-wave generator	8.3.7.4.	8.7./11.9.
	R646/unit 13	Adjust for optimal square-wave response	Square-wave generator	8.3.7.4.	8.8.
	R357/C329/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.5.	8.7./11.9.
Square-wave response channel B	R353/C327/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.5.	8.7./11.9.
	R354/C328/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.5.	8.7./11.9.
	R344/C324/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.5.	8.7./11.9.
	C333/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.5.	8.7./11.9.
Bandwidth check	—	Check for 100 MHz bandwidth	Sine-wave generator	8.3.7.6.	—

Adjusting and adjustment sequence	Adjusting element	Measuring values and explanation	Measuring instrument	Chapter	Figures
Common mode rejection	—	Check according to table	Sine-wave generator	8.3.7.7.	—
Dynamic range and position range	—	Check for distortion	Sine-wave generator	8.3.7.8.	—
Chopped mode check	—	Check chopper function	—	8.3.7.9.	—
Alternate mode check	—	Check alternate function	—	8.3.7.10.	—
Square-wave response trigger view via external trigger input	C819/unit 9	Adjust for optimal square-wave response	Square-wave generator	8.3.7.11.	8.8./11.7.
Square-wave response trigger view via channel A	C714/unit 16				
	R409/C404/C407/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.12.	8.7./11.9.
	R411/C408/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.12.	8.7./11.9.
	R416/C411/unit 12				
Square-wave response trigger view via channel B	R459/C454/C457/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.12.	8.7./11.9.
	R461/C458/unit 12	Adjust for optimal square-wave response	Square-wave generator	8.3.7.12.	8.7./11.9.
	R466/C461/unit 12				
Bandwidth check trigger view via channel A (B)	—	Check bandwidth	Sine-wave generator	8.3.7.13.	—
Bandwidth check trigger view via external input	—	Check bandwidth	Sine-wave generator	8.3.7.14.	—
8.2.8. Triggering					
Trigger slope and level of MTB		Starting point of trace may not change when the +/— slope switch is operated	Sine-wave generator	8.3.8.1.	8.8.
	R860/unit 9	Adjust the TTL trigger mode	Square-wave generator	8.3.8.1.	8.8.
Trigger sensitivities of MTB	—	Check according to table	Sine-wave generator	8.3.8.2.	—
Single sweep mode	—	Check single sweep function	Sine-wave generator	8.3.8.3.	—
Mains triggering	—	Check the mains (line) trigger function: the display must be stable	—	8.3.8.4.	—
Trigger slope and level of DTB		Starting point of trace may not change when the +/— slope switch is operated	Sine-wave generator	8.3.8.5.	8.8.
		Adjust the range of the level control	Sine-wave generator	8.3.8.5.	8.8.
	R1260/unit 9	Adjust the TTL trigger mode	Square-wave generator	8.3.8.5.	8.8.
Trigger sensitivities of DTB	—	Check according to table	Sine-wave generator	8.3.8.6.	—
8.2.9. Jitter	—	Check for a jitter-free display	Square-wave generator	8.3.9.	—
8.2.10. Periodic and random deviations	—	Check ripple	—	8.3.10.	—
		Check noise	—		
		Check microphony	—		
		Check for power supply converter interference	—		
		Check for trace instability	—		
		Check for parasitic Z-modulation	—		
8.2.11. Effect of mains voltage variations	—	Check instrument performance when varying mains voltage	Variable mains transformer	8.3.11.	—
8.2.12. Horizontal amplifier					
Bandwidth check	—	Check the bandwidth	Sine-wave generator	8.3.12.1.	—
Phase difference check	—	Check phase difference between X and Y channels	Sine-wave generator	8.3.12.2.	8.6.

8.3. CHECKING AND ADJUSTING PROCEDURE

8.3.1. Power supply

8.3.1.1. Power consumption

- Check that the voltage has been set to the local mains voltage and connect the instrument to such a voltage
- Switch the oscilloscope on and check that the pilot lamp on the front panel lights up
- Check that the power consumption does not exceed 60W (measured with a moving-iron meter)

8.3.1.2. +12,7V supply voltage (unit 5)

- Check at nominal mains voltage that the voltage on the positive pole of C1831 is $+12,7V \pm 100mV$; if necessary, readjust potentiometer R1826 on the power supply board.
- Check that this voltage does not vary more than $\pm 50mV$ when the mains voltage is varied between -10% and $+20\%$.

8.3.1.3. Pre-set potentiometer R1827 (FREQ.)

This potentiometer is a factory adjustment control. THE SETTING OF THIS POTENTIOMETER MUST NOT BE DISTURBED UNLESS IT IS ABSOLUTELY IMPOSSIBLE TO SET THE $+12,7V$ WITH THE AID OF POTENTIOMETER R1826.

Adjusting procedure:

- Set the mains input voltage to 220V
- Turn potentiometer R1827 fully anti-clockwise) *SEE NOTE ABOVE*
- Check that the voltage on the positive pole of C1831 is $+12,7V \pm 100mV$; if necessary; readjust potentiometer R1826 on the power supply board.
- Set the mains input voltage to 170V
- Check that the voltage on the positive pole of C1831 is $+12,7V \pm 100mV$; if necessary; readjust potentiometer R1826 on the power supply board.

8.3.1.4. Supply voltages for unit 12

- Adjust potentiometer R1654 on unit 12 for a correct $+11,4V$ accross C1653.
- Adjust potentiometer R1673 on unit 12 for a correct $-11,4V$ accross C1661

8.3.1.5. Cathode voltage (unit 11)

- Check that the cathode voltage is $2150V \pm 21,5V$
- If necessary, readjust potentiometer R2048 on the Z amplifier board

8.3.2. Calibration generator

If necessary, check the supply voltages first, refer to section (8.3.1.)

- Check the calibration square wave on irregularities
- Check that the amplitude of the CAL voltage is $3V \pm 1\%$; if necessary, readjust potentiometer R1906 on the calibration board (unit 17)
- Check that the frequency of the CAL voltage is $2kHz, \pm 2\%$
- Check that the CAL current is $6mA \pm 1\%$.

8.3.3. Cathode-ray tube circuit

8.3.3.1. Focus and astigmatism (unit 11)

- Check that the controls occupy the positions indicated in section 8.1.3.
- Depress push-button A of the display-mode controls (S1)
- Apply a sine-wave signal at a frequency of 100 kHz to input A
- Adjust the trace height to 6 DIV, using the AMPL switch and vernier
- Set the MAIN TIME/DIV switch and the LEVEL control to such a position that several complete cycles are displayed

- Set the INTENS potentiometer for normal brightness
- Check that an evenly sharp trace can be obtained with the aid of the FOCUS potentiometer. If necessary, readjust potentiometer **R2037** on the **Z amplifier unit**. After this adjustment, the FOCUS potentiometer must be approximately in mid-position. If necessary, this may be corrected by selecting a different value for resistor **R2074** ($\approx 2M25$) on the Z amplifier unit.
- Increase the trace brightness using the INTENS potentiometer
- Check that still a sharp trace may be obtained with the aid of the FOCUS potentiometer. If necessary, optimize with the aid of **R2037**
- Remove the input signal.

8.3.3.2. Trace rotation

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X-deflection controls (S2)
- Centre the time-base line using the POSITION control
- Check that the time-base line runs exactly in parallel with the horizontal graticule lines; if necessary, readjust the TRACE ROT control (R15) on the front panel.

8.3.3.3. Orthogonality (unit 26)

- Depress push-button ALT of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Set the switch of the channel A signal-coupling controls to 0
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TB switch to 5 μ s
- Set the channel B AMPL switch to 5 mV/DIV and its vernier control to CAL
- Apply a sine-wave voltage of 120mV, frequency 100kHz, to input B
- Depress push-button B of the d.t.b. trigger source controls (S21)
- Adjust the d.t.b. LEVEL control for the triggering of the d.t.b.
- Centre the intensified part of the trace, using the DELAY TIME control (R1).
- Centre the channel A time-base line, using the channel A POSITION potentiometer
- Check that the angle between the horizontal and vertical line is 90° , see fig. 8.2. If necessary, readjust **R1737** on the final X-amplifier.

8.3.3.4. Geometry (= barrel and pin cushion distortion) (unit 26)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Apply a sine-wave voltage at a frequency of approx. 100kHz to input A
- Set the channel A signal coupling control to DC
- Set the AMPL./DIV. control of channel A to obtain a trace height of 7,4 DIV.
- Apply a sine-wave voltage at a frequency of approx. 50Hz to input B
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Depress push-button B of the main time-base trigger-source controls (S22)
- Set the channel B AMPL switch and vernier control to obtain a display width of 9,4 DIV.
- Check that the edges of the display lie within the hatched area shown in fig. 8.3.; if necessary, readjust potentiometer **R2039** on the final X-amplifier.
- Remove the input signals

8.3.3.5. Intensity (unit 11)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button DEL'D TB of the X deflection controls (S2)
- Turn the INTENS potentiometer clockwise
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TIME/DIV switch to 1 μ s
- Set the switch of the signal-coupling control of channel A to 0
- Depress push-button MAIN TB of the delayed time-base trigger-source controls
- Check that there is a barely visible dot at the beginning of the trace. If necessary, readjust potentiometer **R2071** on the **Z amplifier board**

- Resistor R2012 will be a "select in test" resistor of 7k15 15k.
Adjust the intensity (beam current) in such a way that the voltage across R2087 lies, between 10 μ V and 20 μ V. Adjust if possible for 20 μ V across R2087. In case that the dead angle of R16 will be too great (more than 120°), a different value for R2012 ($\approx > 15k$) must be selected. Repeat this procedure after replacement of a C.R.T.

8.3.3.6. Intensity ratio (unit 8)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Turn the DELAY TIME control (R1) to 5.0 (mid-position)
- Set the MAIN TIME/DIV switch to .2 ms and the DEL'D TIME/DIV switch to 50 μ s
- Set the switch of the channel A signal-coupling control to AC
- Apply a sine-wave signal at a frequency of 100 kHz to input A
- Set the display-height to 6 DIV
- Set the INTENS potentiometer to a position 90° from the anti clockwise stop; see Fig. 8.4.
- Check that the trace of the main time-base generator is barely visible over the entire screen and that the part determined by the delayed time-base generator is more brilliant. If necessary, readjust potentiometer R1537 on the time-base board

8.3.4. Balance adjustments

The adjustments of the vertical channels A and B are identical.

The knobs, sockets and adjusting elements of channel B are shown in brackets after those of channel A.

The balance adjustments influence one another and must, therefore, be readjusted in the order in which they are described.

8.3.4.1. 0-DC Balance (Attenuator unit)

- Depress push-button A (B) of the display-mode controls (S1)
- Set the channel A (B) AMPL switch to 5 mV/DIV and the vernier control to CAL.
- Centre the time-base line, using the POSITION potentiometers
- Set the channel A (B) signal coupling switch from 0 to DC
- Check that the trace does not jump; if necessary, readjust potentiometer R124 (Ch. A) or R174 (Ch. B) on the attenuator board.

8.3.4.2. Attenuator balance (Attenuator unit)

- Depress push-button A (B) of the display-mode controls (S1)
- Set the switches of the channel A (B) signal-coupling controls to 0
- Centre the time-base line, using the POSITION controls
- Turn the AMPL switch between 5 V/DIV and 10 mV/DIV
- Check that the trace does not jump more than 0,1 DIV; if necessary, readjust potentiometer R129 (Ch. A) or R179 (Ch. B) on the attenuator board.

8.3.4.3. Continue balance (unit 12)

- Depress push-button A (B) of the display-mode controls (S1)
- Set the switches of the channel A (B) signal-coupling controls to 0
- Rotate the channel A (B) AMPL vernier control between minimum and maximum
- Check that the trace does not move more than 1 DIV in the 2 mV/DIV position, 0,4 DIV in the 5 mV/DIV position and 0,2 DIV in the other attenuator positions; if necessary, readjust potentiometer R211 (R311) on the intermediate amplifier board.

8.3.4.4. Balance 5mV/div (unit 12)

- Depress push-button A (B) of the display-mode controls (S1)
Set the switches of the channel A (B) signal-coupling controls to 0
- Centre the time-base line, using the POSITION controls
- Check that the trace does not move more than 1 DIV when the AMPL switch is turned from 5 mV/DIV to 2mV/DIV and not more than 0,2DIV in the other positions and when the Ampl./DIV. is turned from 5mV/DIV to 10mV/DIV, minimum trace jumps; if necessary readjust potentiometer R216 (R316) on the intermediate amplifier board.

8.3.4.5. Polarity (Norm/Invert) balance (unit 12)

- Depress push-button A (B) of the display-mode controls (S1)
- Set the switches of the channel A (B) signal-coupling controls to 0
- Centre the time-base line, using the POSITION controls
- Set the channel A (B) AMPL switch to 10 mV/DIV
- Check that the time-base line does not shift more than 0,3 DIV when the channel A (B) POSITION control is pulled to INVERT; if necessary, readjust potentiometer **R259 (R359)** on the intermediate amplifier board.
- Set the channel A (B) AMPL switch to 2 mV/DIV
- Check that the time-base line does not shift more than 2 DIV, see also section 1.2.2., when the channel A (B) POSITION control is pulled to INVERT; if necessary, readjust potentiometer **R259 (R359)** on the intermediate amplifier board.

8.3.4.6. Trigger balance main time-base (unit 16, unit 12, unit 9)

- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Depress push-button A of the display-mode controls (S1)
- Depress push-button DC of the m.t.b. trigger-coupling controls (S20)
- Depress push-button AUTO of the trigger-mode controls (S8)
- Set the m.t.b. LEVEL potentiometer in its mid-position
- Set the MAIN TIME/DIV switch to 1 msec and its vernier to CAL
- Set the DEL'D TIME/DIV switch to OFF
- Set the potentiometer R431 in its mid-position
- Set the switch of the channel A signal coupling control to AC
- Apply a sine-wave signal, frequency 1 kHz to input A, amplitude on the screen must be 1 div.
- Adjust R835 on the trigger amplifier for a triggered display
- Check that the starting point of the signal does not move when the m.t.b. SLOPE switch is set from + to –; if necessary, readjust potentiometer R881 on the trigger-amplifier
- Depress push-button TRIG of the trigger-mode controls (S8)
- Depress push-button HF of the m.t.b. trigger-coupling controls (S20)
- Set the switch of the channel A signal coupling control to 0 (S17)
- Remove stocko-connector from socket 4 of the trigger-amplifier
- Set R845 fully clockwise and adjust R845 anti-clockwise until the time-base line writes 1x
- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Depress push-button AUTO of the trigger-mode controls (S8)
- Reinsert stocko-connector in socket 4 of the trigger-amplifier
- Centre the trigger view line with the m.t.b. LEVEL potentiometer
- Depress push-button DC of the m.t.b. trigger-coupling controls (S20)
- Check that the trigger-view line remains in the screen centre; if necessary, readjust potentiometer R431 on the intermediate amplifier board
- Depress push-button B of the m.t.b. trigger-source controls (S22)
- Check that the trigger-view line remains in the screen centre; if necessary, readjust potentiometer R481 on the intermediate amplifier board
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Check that the trigger-view line remains in the screen centre; if necessary, readjust potentiometer R729 on the trigger source board
- Depress push-button A of the display-mode controls (S1)
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the switch of the channel A signal coupling control to AC
- Centre the time-base line using the channel A position control
- Apply a sine-wave signal with a frequency of 1 kHz to input A, amplitude on the screen must be 1 div.
- Shift the starting point of the sine-wave to the central horizontal graticule line, using the m.t.b. LEVEL control
- Depress push-button TRIG VIEW of the display-mode control (S1)
- Shift the starting point of the sine-wave to the central horizontal graticule line, potentiometer R527 on the intermediate amplifier board
- Remove the input signal
- Set the MAIN TIME/DIV switch to .1 msec and its vernier to CAL

- Set the starting point of the m.t.b.-line to the first vertical graticule line, using the X-POSITION potentiometer
- Depress push-button EXT of the X deflection controls (S2)
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Shift the point to the central vertical graticule line, selecting resistor R1523 on the time-base (UNIT 8)
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Shift the point to the first vertical graticule line, selecting resistor R737 on the trigger-source board

8.3.4.7. Trigger balance delayed time-base (unit 12, unit 9)

- Depress push-button DEL'D TB of the X deflection controls (S2)
- Set the MAIN TIME/DIV switch to $.5 \mu\text{s}$ and its vernier to CAL
- Set the DEL'D TIME/DIV switch to $.2 \mu\text{s}$ and its vernier to CAL
- Depress push-button HF of the d.t.b. trigger-coupling controls
- Depress push-button A of the display-mode controls (S1)
- Set the channel A AMPL switch to 20 mV/DIV and its vernier to CAL
- Depress push-button A of the d.t.b. trigger-source controls (S21)
- Apply a sine-wave voltage of 120 mV, frequency 1 MHz, to input A
- Set the d.t.b. LEVEL potentiometer in its mid position.
- Adjust R1235 on the trigger amplifier p.c. board for a triggered display
- Centre the display, using the channel A POSITION control
- Shift the starting point of the sine-wave to the central horizontal graticule line, using the d.t.b. LEVEL potentiometer.
- Check that the starting point of the signal does not move when the d.t.b. SLOPE switch is set from + to —; if necessary, readjust potentiometer R1268 on the trigger amplifier (unit 9)
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Check that the starting point of the sine-wave remains in the centre of the screen; if necessary, readjust potentiometer R428 on the intermediate amplifier board.
- Depress push-button B of the display-mode controls (S1)
- Set the channel B AMPL switch to 20 mV/DIV and its vernier to CAL
- Depress push-button HF of the d.t.b. trigger-coupling controls
- Depress push-button B of the d.t.b. trigger-source controls (S21)
- Apply a sine-wave voltage of 120 mV, frequency 1 MHz, to input B
- Centre the display, using the channel B POSITION control
- Shift the starting point of the sine-wave to the central horizontal graticule line, using the d.t.b. LEVEL control.
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Check that the starting point of the sine-wave remains in the centre of the screen; if necessary, readjust potentiometer R478 on the intermediate amplifier board
- Remove the input signal.

8.3.4.8. Y Position correction and ADD balance adjustment (unit 12 and 13)

- Depress push-button A of the display-mode controls (S1)
 - Depress push-button MAIN TB of the X-deflection controls (S2)
 - Set the vertical POSITION potentiometer to its mid-position
 - Short-circuit the input of the delay-line on the intermediate amplifier board (Unit 12)
 - Check that the time-base line is displayed exactly in the centre of the screen; if necessary, readjust potentiometer R658 on the final Y-amplifier board.
 - Remove the short-circuit on the intermediate amplifier board
 - Depress push-button ALT of the display-mode controls (S1)
 - Shift the A and B traces in opposite direction, by means of the POSITION controls.
 - Depress push-button ADD of the display-mode controls (S1)
 - Readjust potentiometer R500 on the intermediate amplifier so that the trace appears in the centre of the screen.
 - Depress push-button ALT of the display-mode controls (S1)
 - Shift both traces to the centre of the screen with the POSITION controls
 - Depress push-button ADD of the display-mode controls (S1)
 - Readjust potentiometer R500 for minimum trace jump
- If necessary, repeat this procedure

8.3.4.9. TB MAGN balance (unit 26)

- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button A of the display-mode controls (S1)
- Move the starting point of the time-base line to the centre of the screen, using the X POSITION control
- Check that the starting point does not move when the TB MAGN control is operated; if necessary, readjust potentiometer **R1749** on the final X-amplifier (unit 26)

8.3.5. Time-base generators

8.3.5.1. Main time-base time coefficients (unit 8)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button AUTO of the trigger-mode controls (S8)
- Set the d.t.b. TIME/DIV switch to OFF and its vernier to CAL
- Depress push-button DC of the m.t.b. trigger-coupling controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the channel A AMPL switch to .1 V/DIV and its vernier to CAL
- Set the switch of the channel A signal-coupling control to DC
- Apply a time-marker signal of 600 mV, pulse repetition rate 1 ms, to the channel A input
- Push the TB MAGN switch to x1
- Set the m.t.b. TIME/DIV switch to 1 ms and its vernier to CAL
- Adjust the m.t.b. LEVEL potentiometer for a stable display.
- Check that the pilot lamps x10 and time-base UNCAL are off
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1709** on the final X-amplifier (unit 26)
- Set the m.t.b. TIME/DIV switch to 5 ms
- Change the repetition rate of the input signal to 5 ms
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R913** on the time-base board
- Set the m.t.b. TIME/DIV switch to 1 μ s
- Change the repetition rate of the input signal to 1 μ s.
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R911** on the time-base board.
- Pull the TB MAGN switch to x10
- Check that the x10 pilot lamp lights up
- Change the repetition rate of the input voltage to .1 μ s
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1706** on the final X-amplifier (unit 26)
- Push the TB MAGN switch to x1
- Set the m.t.b. TIME/DIV switch to .1 μ s
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust trimmer capacitor **C916** on the time-base board
- Check that the other positions of the m.t.b. TIME/DIV switch, using the appropriate input signals; tolerance $\pm 2\%$ at an ambient temperature of 20 to $+30^\circ\text{C}$.
- Check that the control range of the m.t.b. TIME/DIV vernier control is 1:2,6 to 1:3,5 and that the pilot lamp UNCAL lights up as soon as the vernier is out of its CAL position.

8.3.5.2. Delayed time-base time coefficients (unit 8)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button DEL'D TB of the X deflection controls (S2)
- Depress push-button AUTO of the trigger-mode controls (S8)
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Rotate the DELAY TIME control (R1) fully anti-clockwise (minimum delay time)
- Push the TB MAGN switch to x1
- Depress push-button A of the d.t.b. trigger-source controls (S21)
- Set the m.t.b. TIME/DIV switch to 2 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to 1 ms and its vernier to CAL
- Check that the time-base UNCAL lamp is off
- Apply a time-marker signal of 600 mV, repetition rate 1 ms, to the channel A input
- Set the channel A AMPL switch to .1 V/DIV and its vernier to CAL
- Adjust the d.t.b. LEVEL control for a stationary display
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1326** on the time-base board
- Set the m.t.b. TIME/DIV switch to 10 ms
- Set the d.t.b. TIME/DIV switch to 5 ms
- Change the repetition rate of the input signal to 5 ms
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1318** on the time-base board
- Set the m.t.b. TIME/DIV switch to 2 μ s
- Set the d.t.b. TIME/DIV switch to 1 μ s
- Change the repetition rate of the input signal to 1 μ s
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust potentiometer **R1321** on the time-base board
- Set the m.t.b. TIME/DIV switch to .2 μ s
- Set the d.t.b. TIME/DIV switch to .1 μ s
- Change the repetition rate of the input signal to .1 μ s
- Check that the centre 8 cycles have a total width of 8 DIV; if necessary, readjust trimmer capacitor **C1311** on the time-base board
- Check the sweep times in all other positions of the d.t.b. TIME/DIV switch; tolerance $\pm 2\%$ in temperature range +20 ... +30 °C. Keep during this check the DELAY TIME control fully anti-clockwise and the m.t.b. TIME/DIV switch one position slower than the d.t.b. TIME/DIV switch.
- Check that the control range of the d.t.b. TIME/DIV vernier control is 1:2,6 to 1:3,5 and that the pilot lamp UNCAL lights up as soon as the vernier is out of its CAL position.

8.3.5.3. V.C.O. adjusting (unit 23). Refer to fig. 8.1.

- Check that the mechanical click position of the SET potentiometer R1 is in the centre of the rotation angle (stop position).
- Check the voltage (UP/DOWN) on point 1 of D2301.

UP : 0 V = logic 0

DOWN: +5 V = logic 1

The cross-over point (A) of this voltage must coincide with the click-position of the SET potentiometer R1. If necessary, the symmetry of the up and down ranges of the SET potentiometer R1 can be adjusted with potentiometer R2313 (SYMM.).

- Check the voltage on point 6 of D2302.

This must be +5 V (logic 1) in the STOP position of SET potentiometer R1 and 0 V (logic 0) in the UP and DOWN ranges.

The width of the STOP-range of SET potentiometer R1 is adjustable with potentiometer R2302 (GAP).

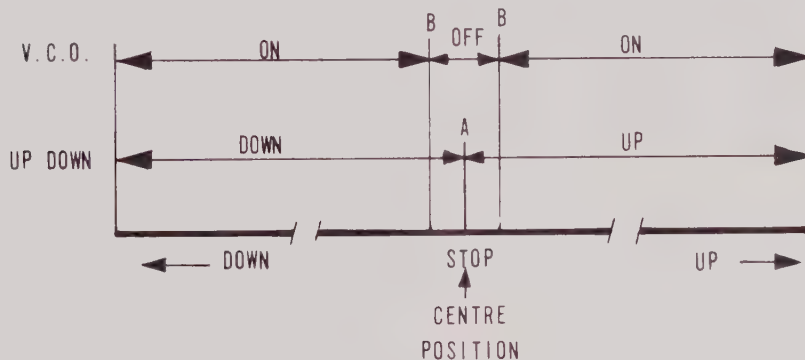


Fig. 8.1. Control range SET potentiometer R1

A = cross-over point UP/DOWN

B = switching points V.C.O. ON/OFF

- Check that the V.C.O. frequency is 1 Hz at the moment that the V.C.O. circuit is enabled (points B in fig. 8.1.).

If necessary, adjust potentiometer R2321 (FREQ.).

The maximum V.C.O. frequency must be approximately 50 Hz.

Note that if switching to the FAST mode (SET knob pushed) the V.C.O. frequency is not changing.

The FAST action is realised by the microprocessor which then counts in steps of 100 instead of steps of 1.

8.3.5.4. Dual DAC adjusting (unit 9)

- Depress push-button AUTO of the trigger mode controls.
- Depress push-button MTB of the X-deflection controls.
- Depress push-button MTB of the d.t.b. trigger source controls.
- Set the m.t.b. TIME/DIV switch to 1 ms/DIV and its vernier to CAL.
- Set the d.t.b. TIME/DIV switch to 10 μ s/DIV and its vernier to CAL.
- Apply a time marker voltage with a repetition rate of 1 ms to the channel A input.

Note: For accurate comparison of the DELAY and ΔT markers, the DTB or ALT TB X-deflection mode may be selected.

- Depress push-button DELAY.
- Set the delay to 1.00 - 3. (shown on the LED display) with the SET potentiometer.
- Adjust R2602 in such a way that the DELAY marker starts at the beginning of the second division.
- Set the delay to 9.00 - 3.
- Adjust R2606 so, that the DELAY marker starts at the beginning of the 10th division.
- Set the delay to 1.00 - 3.
- Depress push-button ΔT .
- Set the ΔT value to zero with the SET potentiometer (see display).
- Adjust R2613 so, that the ΔT marker coincides with the DELAY marker.

- Release push-button ΔT .
- Set the delay to 9.00 - 3.
- Depress push-button ΔT (check that the ΔT time on the LED display is zero).
- Adjust R2626 so, that the ΔT marker coincides with the DELAY marker at the beginning of the 10th division.
- Release push-button ΔT .
- Set the delay to 1.00 - 3.
- Depress push-button ΔT .
- Set the ΔT to 8.00 - 3.
- Adjust R2617 so, that the ΔT marker starts at the beginning of the 9th division.

If necessary, repeat the whole procedure.

8.3.5.5. *Alternate time-base and trace separation*

- Depress push-button A of the display-mode controls (S1)
- Depress push-button ALT TB of the X deflection controls (S2)
- Set the m.t.b. TIME/DIV switch to .5 μs and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to .05 μs and its vernier to CAL
- Set the switch of the channel A signal-coupling control to 0
- Check that the distance between the two traces is 0 DIV with the TRACE SEP control turned anti-clockwise and approximately 4 DIV with this control turned clockwise.

8.3.6. **L.F. correction and sensitivities**

Before checking the sensitivities, check the balances in accordance with section 8.3.4. Balance adjustments.

8.3.6.1. *L.F. correction amplifier (unit 2)*

- Depress push-button A (B) of the display mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel A (B) signal coupling controls to DC
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Set the channel A (B) AMPL switch to 10mV/DIV and its vernier to CAL
- Set the m.t.b. TIME/DIV switch to .5ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage of 60mV, repetition rate 200Hz, to the channel A (B) input
- Check that the pulse top is straight; if necessary, readjust potentiometer R132 (ch. A) or R182 (ch.B) on the attenuator board.

8.3.6.2. *L.F. correction MTB external input (unit 16)*

- Depress push-button TRIG VIEW of the display mode selector S1
- Depress push-button MAIN TB of the horizontal deflection selector S2
- Depress push-button EXT of the MTB trigger source selector S22
- Depress push-button DC of the MTB trigger coupling switch S20
- Set MTB TIME/DIV switch in the 0,1 ms/DIV. position
- Set the DTB TIME/DIV switch in the OFF position
- Apply a 2kHz/600mV square-wave signal to the MTB external input socket X7
- Position the wave form on the screen by means of the MTB level control R7
- Check that the pulse top is straight; if not adjust potentiometer R736 on the trigger source unit (unit 16)
- Remove the input signal

8.3.6.3. *L.F. correction DTB external input (unit 16)*

- Depress push-button TRIG VIEW of the display mode selector S1
- Depress push-button MAIN TB of the horizontal deflection selector S2
- Depress push-button EXT of the DTB trigger source selector S21
- Depress push-button DC of the DTB trigger coupling switch S19
- Set the MTB TIME/DIV switch in the 0,1 ms/DIV position
- Set the DTB TIME/DIV switch in the OFF position
- Switch the instrument off and change on unit 9 the coax cables for the MTB and DTB trigger signals from unit 16
- Switch the instrument on again
- Apply a 2kHz/600mV square wave signal to the DTB external input socket X6
- Position the waveform on the screen by means of the MTB level control R7
- Check if the pulse top is straight; if not adjust R1118 on the trigger source unit (unit 16)
- Switch the instrument off and change the coax cables for the MTB and DTB trigger signals again
- Switch the instrument on again
- Remove the input signal

8.3.6.4. *Gain (sensitivity) Y_A VIA Y (unit 13)*

- Set front panel GAIN potentiometer R12 in its mid position
- Depress push-button A of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel A signal-coupling control to AC
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the m.t.b. TIME/DIV to 0,2ms/DIV
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel A AMPL switch to .5V/DIV and its vernier to CAL
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel A input
- Check that the trace-height is 6 DIV; if necessary, readjust potentiometer R654 on the final Y amplifier board.
- Check that the control range of the channel A AMPL vernier control is 1 : 2,6 to 1 : 3,5 and that the pilot lamp UNCAL lights up as soon as the vernier is out of the CAL position

8.3.6.5. *Gain (sensitivity) Y_B VIA Y*

- Depress push-button B of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel B signal-coupling control to AC
- Depress push-button B of the m.t.b. trigger-source controls
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel B AMPL switch to .5V/DIV and its vernier to CAL
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel B input
- Check that the trace height is 6 DIV; if necessary, readjust GAIN potentiometer R13 on the front panel
- Check that the control range of the channel B AMPL vernier control is 1 : 2,6 to 1 : 3,5 and the pilot lamp UNCAL light up as soon as the vernier is out of the CAL position
- Remove the input signal

8.3.6.6. *Gain (sensitivity) at external X deflection (unit 16)*

- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Set the X AMPL-HOLD OFF control to CAL
- Apply a 300mV square-wave voltage, frequency 2kHz, to the m.t.b. EXT input
- Adjust the X POSITION potentiometer R2 so that there are two points displayed on the screen
- Check that the trace width is 6 DIV; if necessary, readjust potentiometer R742 on the trigger-source board
- Check that the control range of the X AMPL-HOLD OFF control is 1 : 2,6 to 1 : 3,5
- Set the X AMPL-HOLD OFF control to CAL
- Depress push-button EXT ÷ 10 (S22) of the m.t.b. trigger source controls
- Increase the amplitude of the input signal by a factor of 10

- Check that the trace width is $6 \text{ DIV} \pm 2 \text{ SUBDIV}$
- Remove the input signal

8.3.6.7. Gain (sensitivity) external triggering via TRIG VIEW (unit 9)

- Depress push-button TRIG VIEW of the display mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Set the m.t.b. TIME/DIV. switch to 0,2m sec.
- Position the waveform in the middle of the screen by means of the m.t.b. LEVEL potentiometer.
- Apply a 600mV square-wave voltage, frequency 2kHz, to the m.t.b. EXT input
- Check that the trace height is 6 DIV; if necessary, readjust potentiometer **R842** on the trigger amplifier board.
- Remove the input signal

8.3.6.8. Gain (sensitivity) Y_A TRIG VIEW (unit 12)

- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Set the channel A AMPL switch to .5V/DIV and its vernier to CAL
- Depress push-button A (S22) of the m.t.b. trigger-source controls
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel A input
- Set the channel A and B POSITION controls fully anticlockwise
- Centre the trigger - view waveform by means of the m.t.b. LEVEL control R7
- Check that the trace height is 6 DIV; if necessary readjust potentiometer **R413** on the intermediate amplifier board

8.3.6.9. Gain (sensitivity) Y_B TRIG VIEW (unit 12)

- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Set the channel B AMPL switch to 0.5V/DIV and its vernier to CAL
- Depress push-button B (S22) of the m.t.b. trigger-source controls
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel B input
- Centre the display, using the m.t.b. LEVEL control R7
- Check that the trace height is 6 DIV; if necessary readjust potentiometer **R463** on the intermediate amplifier board

8.3.6.10. Gain (sensitivity) Y_A VIA X

- Depress push-button B of the display-mode controls (S1)
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel A signal-coupling control to AC
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel A AMPL switch to .5V/DIV and its vernier to CAL
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel A input
- Adjust the X POSITION potentiometer R2 so that there are two points displayed on the screen
- Position these two points on the middle of the screen by means of the channel B POSITION control
- Check that the trace width is $6 \text{ DIV} \pm 0,3 \text{ DIV}$

8.3.6.11. Gain (sensitivity) Y_B VIA X

- Depress push-button A of the display-mode controls (S1)
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Push the Y POSITION controls to position NORMAL
- Set the channel B signal-coupling control to AC
- Depress push-button B of the m.t.b. trigger-source controls (S22)
- Set the d.t.b. TIME/DIV switch to OFF
- Set the channel B AMPL switch to .5V/DIV and its vernier to CAL
- Apply a 3V square-wave voltage, frequency 2kHz, to the channel B input

- Adjust the X POSITION potentiometer R2 so that there are two points displayed on the screen.
- Position these two points on the middle of the screen by means of the channel A POSITION control
- Check that the trace width is $6 \text{ DIV} \pm 0,3 \text{ DIV}$.
- Remove the input signal.

8.3.7. Vertical channels

The adjustments of the vertical channels A and B are identical. The knobs, sockets and adjusting elements of channel B are shown in brackets after those of channel A. Before performing the following tests, the balances and sensitivities must be checked in accordance with sections 8.3.4. and 8.3.6.

8.3.7.1. Square-wave response (Attenuator unit)

- Depress push-button A (B) of the display-mode controls (S1)
- Push the Y POSITION controls to NORMAL
- Set the switches of the channel A (B) signal-coupling controls to DC
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Set the m.t.b. TIME/DIV switch to .1ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage with a frequency of 2kHz rise time $\leq 200 \text{ ns}$, to the channel A (B) input; peak to peak value as indicated in the table below
- Check that the pulse top errors do not exceed $\pm 3\%$; if necessary, readjust the relevant trimmers

A (B) AMPL	Y _A (Y _B) input signal	Adjuster	Trace height
2 mV	12 mV	—	6 DIV $\pm 3\%$
5 mV	30 mV	—	6 DIV $\pm 3\%$
10 mV	60 mV	—	6 DIV $\pm 3\%$
20 mV	120 mV	—	6 DIV $\pm 3\%$
50 mV	300 mV	—	6 DIV $\pm 3\%$
.1 V	600 mV	C107 (ch. A) or C157 (ch. B)	6 DIV $\pm 3\%$
.2 V	1,2 V	—	6 DIV $\pm 3\%$
.5 V	3 V	—	6 DIV $\pm 3\%$
1 V	6 V	C112 (ch. A) or C162 (ch. B)	6 DIV $\pm 3\%$
2 V	12 V	—	6 DIV $\pm 3\%$
5 V	30 V	—	6 DIV $\pm 3\%$

- Remove the input signal.

8.3.7.2. Input capacitance (Attenuator unit)

- Depress push-button A (B) of the display-mode controls (S1)
- Push the Y POSITION controls to NORMAL
- Set the switches of the channel A (B) signal-coupling controls to DC
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Set the m.t.b. TIME/DIV switch to .1ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage with a frequency of 2 kHz, rise time $\leq 200 \text{ ns}$, to the channel A (B) input via an 2:1 dummy probe, fig. 8.5.
(1 Mohm $\pm 0,1\%$ // 15 pF); peak to peak value as indicated in the table below
- Check that the pulse top errors do not exceed $\pm 3\%$; if necessary, readjust the relevant trimmers.

Into the dummy probe				
A (B) AMPL	Y _A (Y _B) input signal	Adjuster		Trace height
2 mV	12 mV	C101 (ch. A) or C151 (ch. B)		3 DIV +/-3 %
5 mV	30 mV	—		3 DIV +/-3 %
10 mV	60 mV	—		3 DIV +/-3 %
20 mV	120 mV	—		3 DIV +/-3 %
50 mV	300 mV	—		3 DIV +/-3 %
100 mV	600 mV	C104 (ch. A) or C154 (ch. B)		3 DIV +/-3 %
.2 V	1.2 V	—		3 DIV +/-3 %
.5 V	3 V	—		3 DIV +/-3 %
1 V	6 V	C109 (ch. A) or C159 (ch. B)		3 DIV +/-3 %
2 V	12 V	—		3 DIV +/-3 %
5 V	30 V	—		3 DIV +/-3 %

- Remove the input signal.

8.3.7.3. *Square-wave response final Y amplifier (unit 13)*

- Depress push-button ALT of the display-mode controls (S1)
- Depress push-buttons A and B (COMP) of the m.t.b. trigger-source controls (S22)
- Depress push-button MTB of the X deflection controls (S2)
- Set the Y POSITION controls to obtain a distance of 6 DIV between both time-base lines (channel A time-base line at the top)
- Set the X Magnifier in the x 1 position
- Remove the main time-base connector from the alternate control pulse socket on the intermediate amplifier board, unit 12, socket 9, see fig. 11.9. and 8.8.
- Connect a square-wave with an amplitude of 3V to socket 9
- Both time-base lines will be displayed at a frequency determined by the frequency of the square-wave voltage.

200 Hz (unit 13)

- Set the generator frequency to 200 Hz
- Set the m.t.b. controls to obtain a suitable, triggered display
- Check that the top of the displayed pulse is straight within 2%; if necessary, put R634 in its mid position and select C613 to such a value ($\approx 2n7$) that the square-wave response is optimal.
- Adjust R634 to optimal square wave response.

2 kHz (unit 13)

- Set the generator frequency to 2 kHz
- Set the m.t.b. controls to obtain a suitable, triggered display
- Check that the top of the displayed pulse is straight within 2%; if necessary, put R636 in its mid position and select C614 to such a value ($\approx 39pF$) that the square-wave response is optimal.
- Adjust R636 to optimal square wave response.
- Reconnect socket 9 (fig. 11.9.)

8.3.7.4. *Square-wave response channel A (unit 12 and 13)*

- Depress push-button A of the display-mode controls (S1)
- Push the Y POSITION controls to the NORM position
- Set the switch of the channel A signal-coupling control to DC
- Set the channel A AMPL switch to 10 mV/DIV and its vernier to CAL
- Set the XMagnifier in the X1 position
- Depress push-button MTB of the Xdeflection controls (S2)
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the m.t.b. TIME/DIV switch to a suitable value
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage of 60 mV, rise time 1 ns, repetition rate 2 kHz, to the channel A input
- Check that the pulse top is straight within 2% and that the rise time is as short as possible; if necessary readjust potentiometer R257 or select a different value for capacitor C229 ($\approx 4n7$) on the intermediate Y amplifier adjusting board
- Increase the repetition rate of the input signal to 30 kHz
- Put the instrument in the Magnifier X10 mode for better waveform analysis

- Check that the pulse top is straight within 2% and that the rise time is as short as possible; if necessary, readjust potentiometers R253 and R254 or select a different value for capacitors C227 ($\approx 35\text{pF}$) and C228 ($\approx 1\text{n}$) on the intermediate Y amplifier adjusting board
- Increase the repetition rate of the input signal to 100 kHz
- Check that the pulse is straight within 2% and that the rise time is as short as possible, if necessary, select capacitor C224 ($\approx 27\text{p}$) and readjust potentiometer R244 for an optimal result
- Select C233 on the intermediate amplifier (unit 12) to such a value (between 2p2 and 6p8) that the square wave response is optimal
- Set the generator frequency to 30 kHz
- Set the m.t.b. controls to obtain a suitable, triggered display
- Check that the top of the displayed pulse is straight within 2% ; if necessary, readjust trimmer 616 on the Y amplifier board (unit 13)
- Set the generator frequency to 100 kHz
- Set the m.t.b. controls to obtain a suitable, triggered display
- Check that the top of the displayed pulse is straight within 2% ; if necessary, readjust potentiometer R646 on the final Y amplifier board
- Check the square-wave response in positions 5 mV/DIV and 2 mV/DIV of the AMPL switch at input voltages of 30 mV and 12 mV. The pulse top aberrations must not exceed 2%
- Pull the channel A Y POSITION control to INVERT
- Repeat the checks described above; the response must be the same and the pulse top aberrations must remain within 2%
- Depress push-button B of the display-mode controls (S1)
- Set the switch of the channel B signal-coupling control to 0
- Set the channel B time-base line in the middle of the screen with the POSITION control (R4)
- Depress push-button A of the display-mode controls (S1)
- Set the switch of the channel A signal-coupling control to 0
- Set the channel A time-base line in the middle of the screen with the POSITION control (R3)
- Set the switch of the channel A signal-coupling control to DC
- Depress push-button ADD of the display-mode controls and check that the response does not change
- Check that the pulse top aberrations remain within $\pm 2\%$
- Remove the input signal

8.3.7.5. Square-wave response channel B (unit 12)

- Depress push-button B of the display-mode controls (S1)
- Push the channel A POSITION control to NORM position
- Set the switch of the channel B signal-coupling control to DC
- Set the channel B AMPL switch to 10 m V/DIV and its vernier to CAL
- Set the XMagnifier in the X1 position
- Depress push-button MTB of the X deflection controls (S2)
- Depress push-button B of the m.t.b. trigger source-controls (22)
- Set the m.t.b. TIME/DIV switch to a suitable value
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage of 60 mV, rise time 1 ns, repetition rate 2 kHz, to channel B input
- Check that the pulse top is straight within 2% and the rise time is as short as possible; if necessary readjust potentiometer R357 or select a different value for capacitor C329 ($\approx 4\text{n}7$) on the intermediate Y amplifier adjusting board
- Increase the repetition rate of the input signal to 30 kHz
- Put the instrument in the Magn X10 mode for better waveform analysis
- Check that the pulse top is straight within 2% and that the rise time is as short as possible; if necessary, readjust potentiometers R353 and R354 or select a different value for capacitors C327 ($\approx 33\text{pF}$) and C328 ($\approx 1\text{n}$) on the intermediate Y amplifier adjusting board
- Increase the repetition rate of the input signal to 100 kHz
- Check that the pulse top is straight within 2% and that the rise time is as short as possible; if necessary, select capacitor C324 ($\approx 27\text{p}$) and readjust potentiometer R344 for an optimal result
- Select C333 on the intermediate amplifier (unit 12) to such a value (between 2p2 and 6p8) that the square wave response is optimal

- Check the square-wave response in position 5 mV/DIV and 2 mV/DIV of the AMPL switch at input voltages of 30 mV and 12 mV. The pulse top aberrations must not exceed 2%
- Pull the channel B POSITION control to INVERT
- Repeat the checks described above; the response must be the same and the pulse top aberrations must remain within 2%
- Depress push-button A of the display-mode control (S1)
- Set the switch of the channel A signal-coupling control to 0
- Set the channel A time-base line in the middle of the screen with the POSITION control (R3)
- Depress push-button B of the display-mode controls (S1)
- Set the switch of the channel B signal-coupling control to 0
- Set the channel B time-base line in the middle of the screen with the POSITION control (R4)
- Set the switch of the channel B signal-coupling control to DC
- Depress push-button ADD of the display-mode and check that the response does not change
- Check that the pulse top aberrations remain within $\pm 2\%$
- Remove the input signal

8.3.7.6. Bandwidth

- Depress push-button A (B) of the display-mode controls (S1)
- Push the Y POSITION controls to the NORM position
- Set the channel A (B) AMPL switch to 2 mV/DIV and its vernier to CAL
- Set the switch of the signal coupling control to AC
- Depress push-button MTB of the X deflection controls (S2)
- Push the TB MAGN switch to x1
- Depress push-button AUTO of the trigger-mode controls
- Depress push-button HF of the trigger-coupling controls
- Depress push-button A (B) of the trigger-source controls (S22)
- Set the m.t.b. TIME/DIV switch to 2 μ s and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a sine-wave voltage of 16 mV_{p-p}, frequency 2 MHz , to the channel A (B) input
- Check that the trace height is 8 DIV
- Increase the frequency of the input signal to 35 MHz
- Check that the trace height is at least 5,6 DIV
- Set the channel A (B) AMPL switch to 5 mV/DIV and its vernier to CAL
- Increase the input voltage to 40 mV_{p-p}, frequency 2 MHz
- Check that the trace height is 8 DIV
- Increase the frequency of the input voltage to 100 MHz
- Check that the trace height is at least 5,6 DIV
- Remove the input signal

8.3.7.7. Common-mode rejection

- Depress push-button A of the display-mode controls (S1)
- Set the channel A time-base line in the middle of the screen with the POSITION control (R3)
- Depress push-button B of the display-mode controls (S1)
- Set the channel B time-base line in the middle of the screen with the POSITION control (R4)
- Set the channel A and B signal-coupling switches to DC
- Push the channel A POSITION control to NORM
- Pull the channel B POSITION control to INVERT
- Set both AMPL controls to 10mV/DIV and their verniers to CAL
- Apply a sine-wave voltage of 240mV_{p-p} simultaneously to the channel A and B inputs
- Depress push-button ADD of the display-mode controls (S1)
- Check the rejection in accordance with the following table
- Set the m.t.b. TIME/DIV. switch to a suitable value.

Note: Adjust the channel A or B AMPL vernier control for minimum trace height.

Input voltage	Frequency	Max. trace height	Rejection factor
240 mV	100 kHz	1,2 SUBDIV	> 100
240 mV	2 MHz	1,2 SUBDIV	> 100
240 mV	50 MHz	6 SUBDIV	> 20
– Push the channel B POSITION control to NORM			
– Remove the input signal.			

8.3.7.8. Dynamic range and position range

- Depress push-button A (B) of the display-mode controls (S1)
- Set both AMPL switches to 5mV/DIV and their verniers to CAL
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Apply a sine-wave signal of 120 mV_{p-p}, frequency 10 kHz, to the channel A (B) input
- Check that the top and bottom parts of the sine-wave signal can be displayed, reasonably undistorted, within the measuring graticule, using the channel A (B) POSITON control
- Remove the input signal.

8.3.7.9. Chopped mode

- Depress push-button CHOP of the display-mode controls
- Set the m.t.b. TIME/DIV switch to .2 μ s
- Check that there are two time-base lines displayed which can be shifted in relation to each other, using the Y POSITION controls (R3 and R4)

8.3.7.10. Alternate mode

- Depress push-button ALT of the display-mode controls
- Set the m.t.b. TIME/DIV switch to 10 μ s
- Check that there are two time-base lines displayed which can be shifted in relation to each other, using the Y POSITION controls (R3 and R4)
- Set the m.t.b. TIME/DIV switch to .1 s
- Check that the channels are switched over after every sweep of the time-base voltage.

8.3.7.11. Square-wave response trigger view via EXT

- Depress push-button TRIG VIEW of the display-mode controls
- Depress push-button DC of the m.t.b.-coupling controls
- Depress push-button EXT of the trigger-source controls
- Depress push-button MAIN TB of the X-deflection controls
- Push the Y POSITION controls to the NORM position
- Set the m.t.b. TIME/DIV switch to a suitable position
- Set the dtb TIME/DIV switch to OFF
- Apply a square-wave voltage of 600mV p.p., frequency 100kHz, risetime 1nscc to the m.t.b. EXT input
- Check that the pulse top is straight and that the risetime is as short as possible; if necessary, select capacitor C819 ($\approx$ 22p) on the trigger amplifier P.C. board and capacitor C714 ($\approx$ 1,8p) on the trigger-source P.C. board
- Remove the input signal

8.3.7.12. Square-wave response trigger view via channel A (B) (unit 12)

- Depress push-button TRIG VIEW of the display-mode controls
- Push the Y POSITION controls to the NORM position
- Set the switches of the channel A and B signal-coupling controls to DC
- Set both AMPL switches to 10 mV/DIV and their verniers to CAL
- Depress push-button MTB of the X deflection controls
- Depress push-button A (B) of the m.t.b. trigger-source controls
- Set the m.t.b. TIME/DIV switch to a suitable position
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a square-wave voltage of 60 mV, frequency 2 kHz, rise time 1 ns, to the channel A (B) input
- Depress push-button DC of the m.t.b. signal-coupling control (S20)
- Check that the pulse top of the trigger view signal is straight and the rise-time as short as possible
- Increase the repetition rate of the input signal to 30kHz
- Check that the pulse top is straight within 5% and that the rise-time is as short as possible, if necessary, readjust potentiometers R409 (R459) and select a different value of the capacitors C404 (C454) ($\approx$ 2,7n) and C407 (C457) ($\approx$ 270p) on the intermediate board
- Increase the repetition rate of the input signal to 100kHz
- Check that the pulse top is straight within 5% and that the rise time is as short as possible; if necessary, readjust potentiometer R411 (R461) select a different value of the capacitor C408 (C458) ($\approx$ 82p) and readjust potentiometer R416 (R466) and select a different value of the capacitor C411 (C461) ($\approx$ 39p) on the intermediate amplifier board
- Remove the input signal

8.3.7.13. Bandwidth trigger view via channel A (B)

- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Push the Y POSITION controls to NORM position
- Set both AMPL switches to 10 mV/DIV and their verniers to CAL
- Set the switches of the signal-coupling controls to AC
- Depress push-button MTB of the X deflection controls (S2)
- Push the TB MAGN switch to x1
- Depress push-button AUTO of the trigger-mode controls
- Depress push-button HF of the m.t.b. trigger-coupling controls
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Set the m.t.b. TIME/DIV switch to 2 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a sine-wave voltage of 60 mV_{p-p}, frequency 2 MHz, to the channel A (B) input
- Centre the trigger-view signal by means of the m.t.b. LEVEL control
- Check that the trace height of the trigger view signal is 6 DIV
- Increase the frequency of the input voltage to 80MHz
- Check that the trace height is at least 4,2 DIV
- Remove the input signal

8.3.7.14. Bandwidth trigger view via external input

- Depress push-button TRIG VIEW of the display-mode controls (S1)
- Depress push-button MTB of the X deflection controls (S2)
- Depress push-button EXT of the m.t.b. trigger-source controls (S22)
- Apply a sine-wave voltage of 600 mV_{p-p}, frequency 2 MHz, to the m.t.b. EXT input
- Check that the trace height is 6 DIV
- Increase the frequency of the input signal to 80MHz
- Check that the trace height is at least 4,2 DIV
- Remove the input signal.

8.3.8. Triggering

8.3.8.1. Trigger slope and level of the m.t.b. (unit 9)

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MTB of the X deflection controls (S2)
- Depress push-button DC of the m.t.b. trigger-coupling controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Set the switch of the channel A input-coupling control to DC
- Push the channel A Y POSITION control to the NORM position
- Set the channel A AMPL switch to 20 mV and its vernier to CAL
- Set the m.t.b. TIME/DIV switch to 10 μ s and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Apply a sine-wave voltage of 120 mV_{p-p}, frequency 30 kHz, to the channel A input
- Centre the display, using the POSITION control
- Centre the starting point of the sine-wave, using the m.t.b. LEVEL control
- Check that the starting point of the signal does not move when the SLOPE switch is set from + to —; if necessary, readjust potentiometer R881 on the trigger-amplifier board
- Push the SLOPE switch to its + position
- Check that the time-base generator starts on the positive-going edge of the sine-wave and moves upwards when the LEVEL potentiometer is turned clockwise
- Pull the SLOPE switch to its — position
- Check that the time-base generator starts on the negative-going edge of the sine-wave.
- Set the channel A AMPL switch to 5 mV/DIV
- Rotate the m.t.b. LEVEL control fully clockwise and fully anti-clockwise
- Check that in both extreme positions the time-base generator cuts out and that the NOT TRIG'D lamp lights up, if necessary readjust potentiometer R845 on the trigger amplifier
- Increase the amplitude of the input signal to 160 mV_{p-p}
- Rotate the m.t.b. LEVEL control fully clockwise and anti-clockwise
- Check that in both extreme positions the trace remains triggered and that the NOT TRIG'D lamp does not light up

- Depress push-button TTL of the m.t.b. trigger mode switch
- Set the channel A AMPL/DIV switch to 1V and its vernier to CAL
- Apply a square-wave voltage of 2V p.p., which is superponised on a variable DC voltage, to the channel A input socket. (Use for example a PHILIPS PM5167 function generator).
- A square-wave signal with a trace height of 2 division will now be visible on the screen
- Set the m.t.b. TIME/DIV switch to such a position that a reasonable number of sine-waves is written on the screen
- Set the DC offset knob of the function generator so that the lower level of the square-wave voltage on the screen is shifted to +0,8 division from 0 level
- Adjust R860 so that the signal is just triggered
- Remove the input signal

8.3.8.2. *Trigger sensitivities m.t.b.*

- Depress push-button MTB of the X deflection controls (S2)
- Adjust the m.t.b. LEVEL control for a stationary display
- Set the switches of the signal-coupling controls to DC
- Set the m.t.b. TIME/DIV switch to such a position that a reasonable number of sine waves is written on the screen
- Set the d.t.b. TIME/DIV switch to OFF
- Check the trigger sensitivity in accordance with the table below

Input	Frequency sine wave	Display mode	Trigger mode	Trigger		Trace height/ Volts
				coupling	source	
				MTB	MTB	
A	20 Hz	A	AUTO	DC	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	AUTO	DC	A	0,5 DIV up to 1,5 DIV
A	20 Hz	A	TRIG	DC	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	TRIG	DC	A	0,5 DIV up to 1,5 DIV
A	20 kHz	A	TRIG	LF	A	0,5 DIV up to 1,5 DIV
A	20 kHz	A	TRIG	HF	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	TRIG	HF	A	0,5 DIV up to 1,5 DIV
B	20 Hz	B	TRIG	DC	B	0,5 DIV up to 1,5 DIV
B	20 kHz	B	TRIG	DC	B	0,5 DIV up to 1,5 DIV
B	100 MHz	B	TRIG	DC	B	0,5 DIV up to 1,5 DIV
A and EXT	20 Hz	A	TRIG	DC	EXT	50 mV up to 150 mV
A and EXT	20 kHz	A	TRIG	DC	EXT	50 mV up to 150 mV
A and EXT	100 MHz	A	TRIG	DC	EXT	50 mV up to 150 mV
A and B	20 kHz	ALT	TRIG	DC	A+B	50 mV up to 150mV
A and B	30 MHz	ALT	TRIG	HF	A+B	50 mV up to 150mV

- Remove the input signal

8.3.8.3. *Single-sweep operation*

- Depress push-button A of the display-mode controls (S1)
- Set the channel A AMPL switch to .2 V/DIV and its vernier to CAL
- Depress push-button MTB of the X deflection controls (S2)
- Set the m.t.b. LEVEL control to mid-range
- Set the m.t.b. TIME/DIV switch to .1 s and the vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Depress push-button AUTO of the m.t.b. trigger-mode control (S8)
- Apply a sine-wave signal of 5Hz to the channel A input
- Adjust the trace-height to approximately 6 DIV
- Set the switch of the channel A signal-coupling control to 0
- Push the SINGLE button of the m.t.b. trigger-mode controls (S8)
- Check that the NOT TRIG'D lamp lights up
- Set the switch of the channel A signal-coupling control to AC
- Check that the trace is written once and that the NOT TRIG'D lamp is extinguished at the end of the sweep
- Remove the input signal.

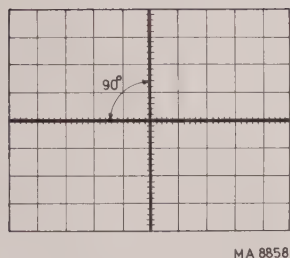


Fig. 8.2. Orthogonality check

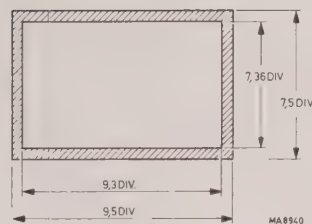


Fig. 8.3. Geometry check

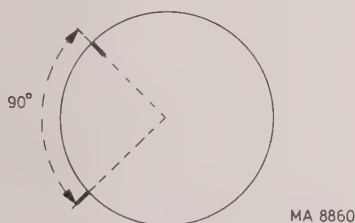


Fig. 8.4. Position of the INTENS potentiometer

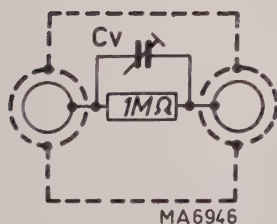


Fig. 8.5. 2:1 Dummy probe

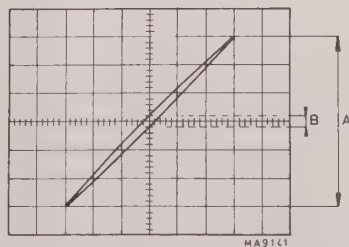


Fig. 8.6. Phase difference in X-Y mode

8.3.8.4. Triggering at mains frequency

- Depress push-button A of the display-mode controls (S1)
- Depress push-button MTB of the X deflection controls (S2)
- Depress push-button AUTO of the trigger-mode controls
- Depress push-button DC of the trigger-coupling controls
- Set the m.t.b. TIME/DIV switch to 5 ms and its vernier to CAL
- Depress push-button EXT of the trigger-source controls (S22)
- Apply a mains voltage derived signal to the channel A input
- Adjust the trace height to approx. 3 DIV; the trace must be running
- Depress push-button EXT and EXT ÷ 10 (S22) simultaneously (LINE)
- Check that a stable display can be obtained, using the m.t.b. LEVEL control
- Remove the input signal.

8.3.8.5. Trigger slope and level of the d.t.b.

- Depress push-button A of the display-mode controls (S1)
- Depress push-button DEL'D TB of the X deflection controls (S2)
- Depress push-button A of the d.t.b. trigger-source controls (S21)
- Depress push-button DC of the d.t.b. trigger-coupling controls
- Push the channel A Y POSITION control to the NORM position
- Set the channel A AMPL switch to 20 mV/DIV and its vernier to CAL
- Depress push-button DELAY
- Set the delay to zero with potentiometer SET.
- Set the m.t.b. TIME/DIV switch to 20 μs and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to 10 μs and its vernier to CAL
- Apply a sine-wave voltage of 120 mV_{p-p}, frequency 30 kHz, to the channel A input
- Centre the display, using the POSITION controls
- Centre the starting point of the sine-wave, using the d.t.b. LEVEL control
- Check that the starting point of the signal does not move when the SLOPE switch is set from + to -
- Push the SLOPE switch to its + position
- Check that the time-base generator starts on the positive-going part of the sine-wave and moves upwards when the d.t.b. LEVEL potentiometer is turned clockwise
- Pull the SLOPE switch to - position
- Check that the time-base generator starts on the negative-going part of the sine-wave
- Set the channel A AMPL switch to 5 mV/DIV and its vernier to CAL
- Rotate the d.t.b. LEVEL control fully clockwise and anti-clockwise
- Check that in both extreme positions the time-base generator cuts out
- Increase the amplitude of the input signal to 160 mV_{p-p}
- Rotate the d.t.b. LEVEL control fully clockwise and anti-clockwise
- Check that in both extreme positions the trace remains triggered.
- Depress push-button TTL of the d.t.b. trigger mode switch
- Set the channel A AMPL/DIV switch to 1V and its vernier to CAL
- Apply a square-wave voltage of 2V p-p, which is superimposed on a variable DC voltage, to the channel A input socket (Use for example a PHILIPS PM 5167 function generator)
- A square-wave signal with a trace height of 2 divisions will now be visible on the screen
- Set the d.t.b. TIME/DIV switch to such a position that a reasonable number of sine-waves is written on the screen
- Set the DC offset knob of the function generator so that the lower level of the square-wave voltage on the screen is shifted to +0.8 division from the 0 level
- Adjust R 1260 so that the signal is just triggered
- Remove the input signal

8.3.8.6. Trigger sensitivities d.t.b.

- Depress push-button DEL'D TB of the X deflection controls (S2)
- Adjust the d.t.b. LEVEL control for a stationary display
- Depress push-button AUTO of the m.t.b. trigger-mode controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Depress push-buttons DC of the signal-coupling controls of the m.t.b.
- Set the m.t.b. TIME/DIV switch one position lower (longer sweep time) than the d.t.b. TIME/DIV switch
- Set the d.t.b. TIME/DIV switch to such a position that a reasonable number of sine waves is written (not for 20 Hz)
- Check the trigger sensitivity in accordance with the table below

Input	Frequency sine wave	Display mode	Trigger coupling d.t.b.	Trigger source d.t.b.	Trace height Volts
A	20 Hz	A	DC	MAIN TB	0,5 DIV up to 1,5 DIV
A	100 MHz	A	DC	MAIN TB	1 DIV up to 1,5 DIV
A	20 Hz	A	DC	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	DC	A	1 DIV up to 1,5 DIV
A	20 Hz	A	LF	A	0,5 DIV up to 1,5 DIV
A	20 kHz	A	LF	A	0,5 DIV up to 1,5 DIV
A	20 kHz	A	HF	A	0,5 DIV up to 1,5 DIV
A	100 MHz	A	HF	A	1 DIV up to 1,5 DIV
B	20 Hz	B	DC	B	0,5 DIV up to 1,5 DIV
B	20 kHz	B	DC	B	0,5 DIV up to 1,5 DIV
B	100 MHz	B	DC	B	1 DIV up to 1,5 DIV
A and EXT dtb	20 Hz	A	DC	EXT	50 mV up to 150 mV
A and EXT dtb	20 kHz	A	DC	EXT	50 mV up to 150 mV
A and EXT dtb	100 MHz	A	DC	EXT	50 mV up to 150 mV

- Remove the input signal.

8.3.9. Jitter

- Depress push-button A of the display-mode controls (S1)
- Depress push-button DELAY
- Set the delay to 9.00 - 3. with the SET potentiometer.
- Push the TB MAGN switch to position x1
- Depress push-button DEL'D TB of the X deflection controls (S2)
- Set the d.t.b. TIME/DIV switch to 2 μ s and its vernier to CAL
- Set the m.t.b. TIME/DIV switch to 1 ms and its vernier to CAL
- Depress push-button AUTO of trigger-mode controls
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Depress push-button MAIN TB of the d.t.b. trigger-source controls (S21)
- Apply a square-wave voltage for a trace height of 4 DIV, repetition rate 20 μ s, to the channel A input
- Adjust the m.t.b. LEVEL control for a stable, triggered display
- Check that the time jitter does not exceed 0,3 DIV
- Depress push-button A of the d.t.b. trigger-source controls (S21)
- Check that a jitter-free display can be obtained, setting the d.t.b. LEVEL control
- Remove the input signal.

8.3.10. Periodic and random deviations

These must be measured only with the cabinet plates fitted

- Inputs of channels A and B open
- Set the switches of the signal-coupling controls of channel A and B to AC
- Set both AMPL switches to 2 mV/DIV and their verniers to CAL
- Depress push-button ALT of the vertical display mode control S1
- Set the DTB TIME/DIV switch to OFF
- Depress push-button MAIN TB of the X deflection controls (S2)
- Depress push-button AUTO of the trigger-mode controls
- Measure the periodic and random deviations in accordance with the following table:

Ripple $\frac{1}{4}$ SUBDIV at maximum
 Noise $\frac{1}{4}$ SUBDIV at maximum
 Microphony $\frac{1}{4}$ SUBDIV at maximum
 Converter interference $\frac{1}{4}$ SUBDIV at maximum
 Instability of the trace $\frac{1}{4}$ SUBDIV at maximum
 Parasitic Z modulation must not be visible

8.3.11. Effect of the mains voltage variations

- Depress push-button CHOP of the display-mode controls (S1)
- Depress push-button MAIN TB of the X deflection controls (S2)
- Pull the TB MAGN switch to x10
- Set the m.t.b. TIME/DIV switch to 2 ms and its vernier to CAL
- Set the d.t.b. TIME/DIV switch to OFF
- Depress push-button AUTO of the trigger-mode controls
- Set both AMPL switches to 0.5 V/DIV and their verniers to CAL
- Set the switches of the signal-coupling controls of channel A and B to AC
- Interconnect the CAL socket and inputs A and B
- Vary the mains voltage by + and – 10 %
- Check that neither trace height nor trace width changes and that the brilliance remains the same
- Remove the input signal from channel A and B

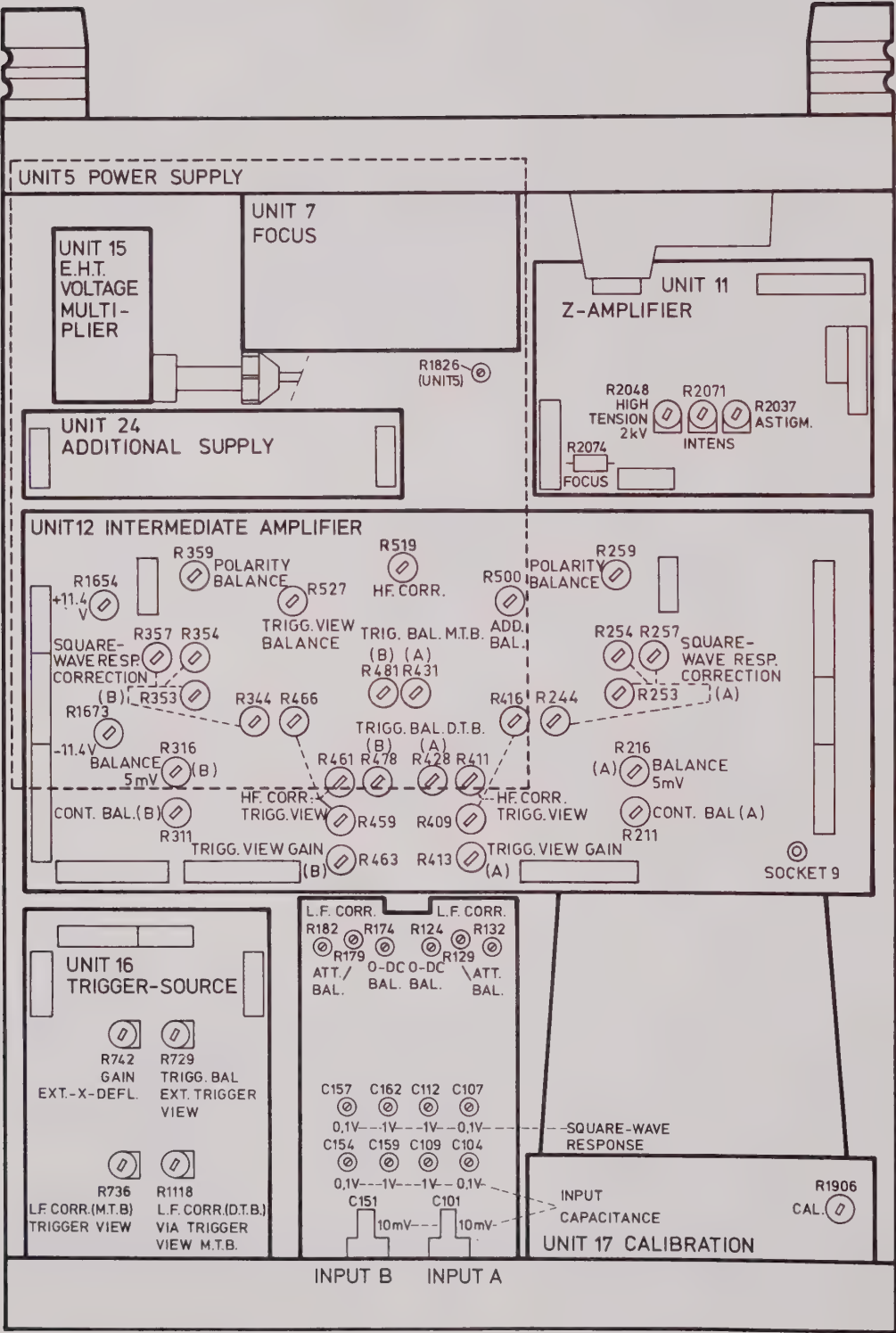
8.3.12. Horizontal amplifier

8.3.12.1. Bandwidth

- Depress push-button B of the display-mode controls (S1)
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Push the TB MAGN switch to x1
- Depress push-button A of the m.t.b. trigger-source controls (S22)
- Apply a sine-wave voltage of 3 V_{p-p}, frequency 2 kHz, to the channel A input
- Check that the trace width is 6 DIV
- Increase the frequency of the input signal to 2 MHz
- Check that the trace width is at least 4,2 DIV
- Remove the channel A input signal

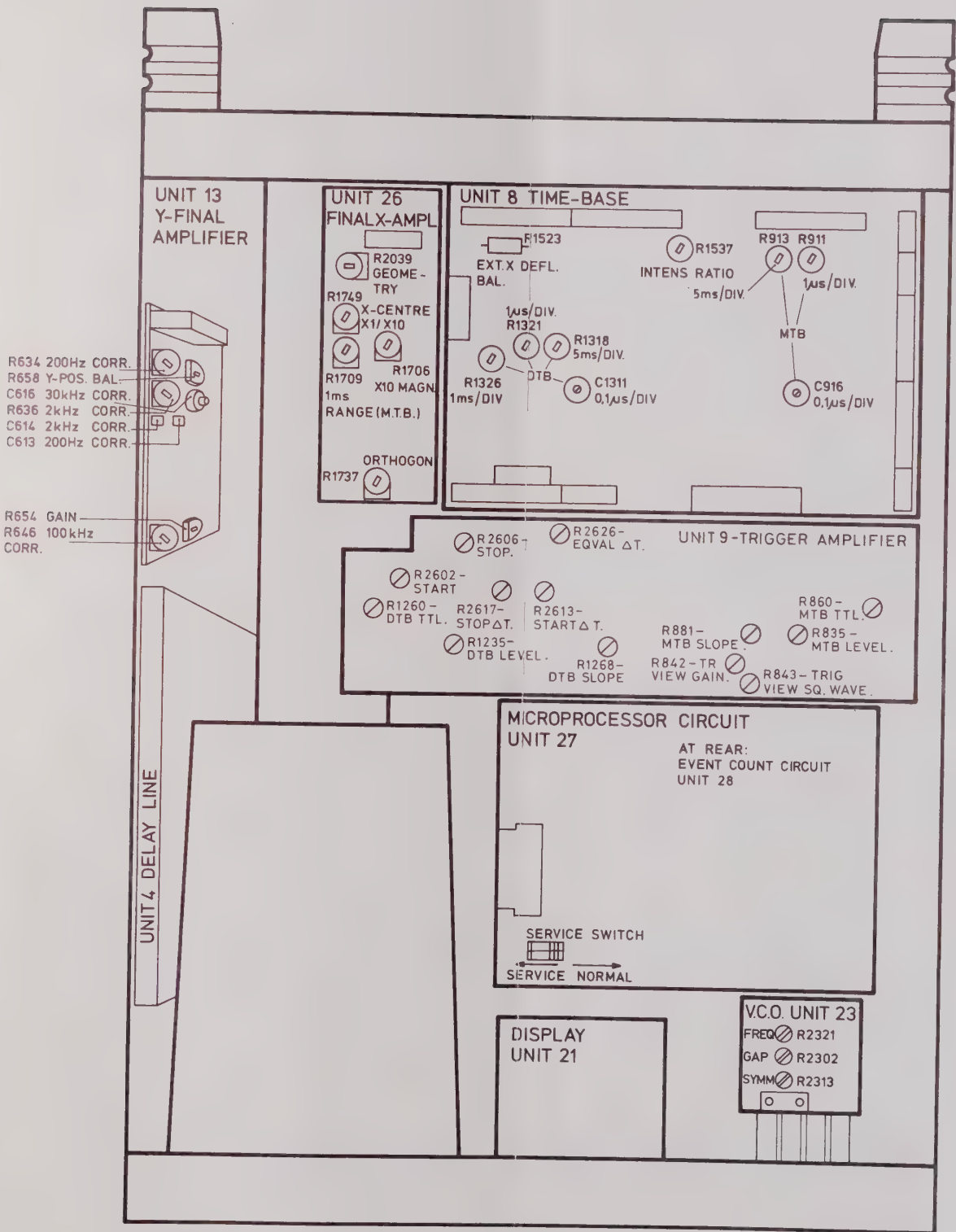
8.3.12.2. Phase difference

- Depress push-button A (B) of the display-mode controls (S1)
- Push the Y POSITION controls to NORMAL
- Set both AMPL switches to 5 mV/DIV and their verniers to CAL
- Set the switches of the signal-coupling controls of channel A and B to DC
- Depress push-button EXT X DEFL of the X deflection controls (S2)
- Depress push-button A (B) of the m.t.b. trigger-source controls (S22)
- Apply a sine-wave voltage of 30 mV_{p.p.}, frequency 100 kHz, to the channel A (B) input
- Check that the phase difference does not exceed 3° (see fig. 8.6.) in which $\frac{B}{A}$ equals the sine of the phase error angle.



MAT 173A

Fig. 8.7. Bottom view with adjusting elements



MAT 174 A

Fig. 8.8. Top view with adjusting elements

9. CORRECTIVE MAINTENANCE

Warning:

The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.
The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the instrument will be opened.
If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the hazard involved. Bear in mind that capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

9.1. IMPORTANT NOTES

Section 9 provides the dismantling procedures required for the removal of components during repair operations. All circuit boards removed from the oscilloscope should be adequately protected against damage, and all normal precautions regarding the use of tools must be observed. Damage may result if the instrument is switched on when a circuit board has been removed, or if a circuit board is removed within one minute after switching off the instrument.

Warning:

The E.H.T. cable is unbreakably connected to the C.R.T. (disconnection at E.H.T. voltage multiplier).
When the E.H.T. cable to the post-acceleration anode of the C.R.T. is disconnected at the E.H.T. unit end, the E.H.T. cable must be discharged immediately by shorting them to the instrument earth.

9.2. REPLACEMENTS

9.2.1. Standard parts

Electrical and mechanical part replacements can be obtained through your local Philips organisation or representative. However, many of the standard electronic components can be obtained from other local suppliers.
Before purchasing or ordering replacement parts, check the parts list for value tolerance, rating and description.

Note:

Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.

9.2.2. Special parts

In addition to the standard electronic components, some special components are used. These components are manufactured or selected by Philips to meet specific performance requirements.

9.2.3. Transistors and integrated circuits

Transistors and IC s (integrated circuits) should not be replaced unless they are actually defective. If removed from their sockets during routine maintenance return them to their original sockets. Unnecessary replacement or switching of semiconductor devices may affect the calibration of the instrument. When a transistor is replaced, check the operation of the part of the instrument that may be affected.

Any replacement component should be of the original type or a direct replacement. Bend the leads to fit the socket and cut the leads to the same length as on the component being replaced.

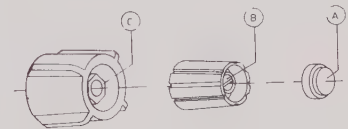
Warning:

Silicone grease is used to facilitate the conduction of heat between power transistors and their heatsink (for instance V1806/unit 5). Handle silicone grease with care. Avoid getting silicone grease in the eyes. Wash hands thoroughly after use.

9.3. REPLACING KNOBS

Single knobs

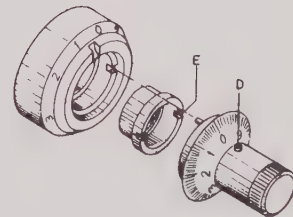
- Prise off cap A
- Slacken screw (or nut) B
- Pull the knob from the spindle



MA5868

Double knobs

- Prise off cap A and slacken screw B
- Pull the inner knob from the spindle
- Slacken nut C and pull the outer knob from the spindle



MAT 190

When fitting a knob or cap, ensure that the spindle is in a position which allows reference lines to be coincident with the markings on the text plate of the oscilloscope.

Fig. 9.1. Removing the knobs

Delay-time multiplier knob

- Slacken screw D using a hexagonal key and pull the knob from the spindle
- Remove the nut E and withdraw the ring from the spindle.

When fitting the vernier control, turn the spindle of the potentiometer fully anticlockwise. Place the ring on the spindle so that the reference line corresponds to the zero mark on the calibrated scale. Then lock it with nut E. Fit the inner knob so that its cam is engaged with the slot in the ring. Rotate the inner knob until its zero mark coincides with the reference line on the ring. Secure the assembly by tightening screw D.

9.4. **SOLDERING TECHNIQUES AND SPECIAL TOOLS**

9.4.1. **General**

Ordinary 60/40 solder and 35– to 40-watt pencil-type soldering iron can be used for the majority of the soldering. If a higher wattage-rating soldering iron is used on the etched circuit boards, excessive heat can cause the etched circuit wiring to separate from the board base material.

9.4.2. **Micro-miniature semi-conductors**

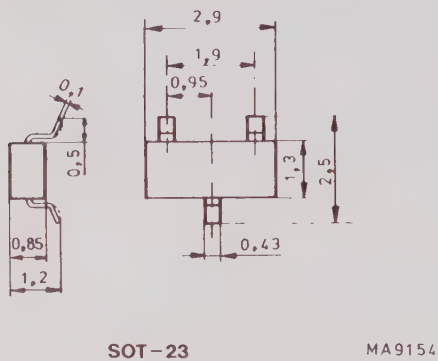


Fig. 9.2. Dimensional drawing of SOT-23 encapsulation

Because of the small dimensions of these SOT semi-conductors and the lack of space between the components on the printed-circuit board, it is necessary to use a miniature soldering iron with a pin-point tip (max. dia 1 mm) to solder a SOT on to a printed-circuit board.

Working method:

- Carefully unsolder one after the other the soldering tags of the semi-conductor.
- Remove all superfluous soldering material. Use a sucking iron or sucking copper litze wire.
- Check that the tags of the replacement part are clean and pre-tinned on the soldering places.
- Locate the replacement semi-conductor exactly in place, and solder each tag to the relevant printed conductor on the circuit board.

Note:

Bear in mind that the maximum permissible soldering time is 10 seconds during which the temperature of the tags must not exceed 250 deg C. The use of a solder with a low melting point is therefore recommended.

Take care not to damage the plastic encapsulation of the SOT during the soldering procedure (softening point of the plastic is 150°C).

Attention:

When soldering inside the instrument it is essential to use a low-voltage soldering iron, the tip of which must be earthed to the mass of the oscilloscope.

Suitable soldering irons are:

- ORYX micro-miniature soldering instrument, type 6A, voltage 6 V, in combination with PLATO pin-point tip type 0-569.
- ERSa miniature soldering iron, type minor 040 B, voltage 6 V.
- Low Voltage Mini Soldering Iron, Type 800/12 W - 6 V, power 12 W, voltage 6 V, order no. 4822 395 10004, in combination with 1 mm-pin-point tip, order no. 4822 395 10012.

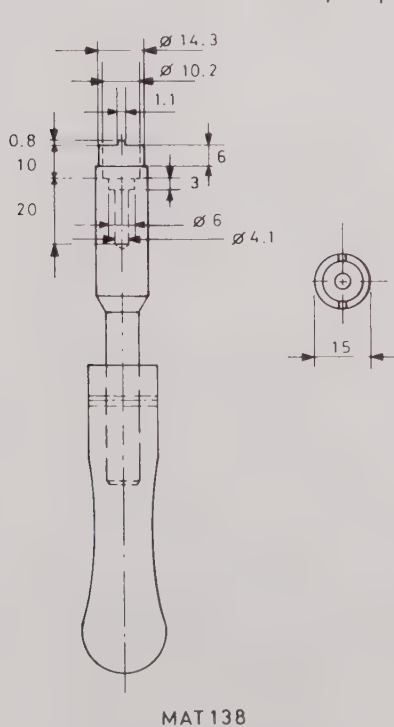
9.4.3. Special tools

Special tool for the slotted nut of attenuator switches A, B, C and D, order no. 5322 395 54023

For those who want to make such a tool, a sketch is given with the dimensions in mm in fig. 9.3. The material is silver steel N094, tempered 40-45 Rc.

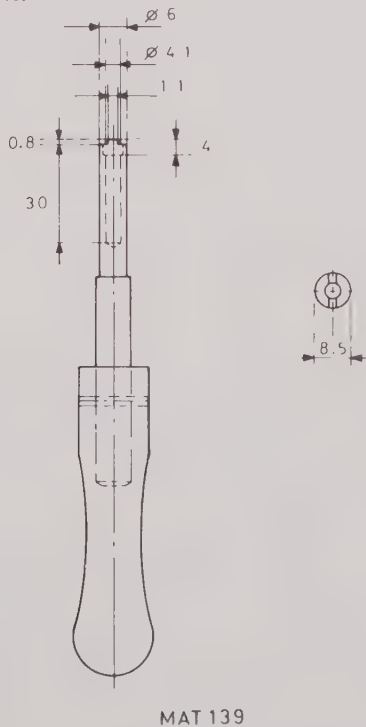
Special tool for the slotted nut of the POSITION and LEVEL/SLOPE potentiometers, order no. 5322 395 54024

For those who want to make such a tool, a sketch is given with the dimensions in mm in fig. 9.4. The material is silver steel N094, tempered 40-45 Rc.



MAT 138

Fig. 9.3. Tool for attenuator unit



MAT 139

Fig. 9.4. Tool for position potentiometer

9.5. REPLACING A PUSH-BUTTON SWITCH

Each of the pushbutton sets is fitted to the front panel by means of two clamping devices secured by hexagon screws, see fig. 9.5.

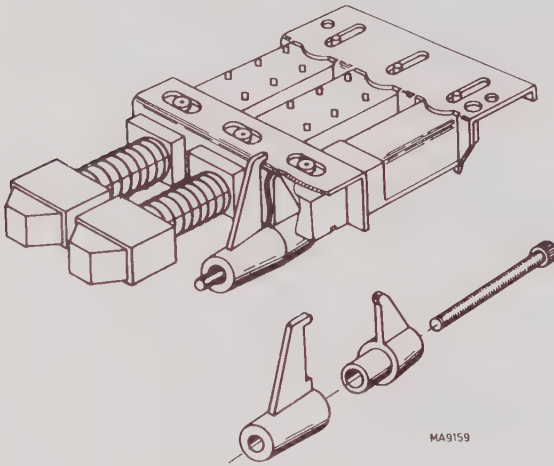


Fig. 9.5. Push-button set clamping device

To remove a pushbutton switch, the hexagon screws that secure it to the front panel must be removed. To replace one switch-section of a push-button set, refer to fig. 9.6.

To remove a pushbutton switch which is mounted on a p.c. board:

- Remove the printed-circuit board for replacing a switch in this unit.
- Straighten the 4 retaining lugs of the relevant switch as shown in fig. 9.6.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed-wiring board (e.g. with a suction soldering iron).
- Solder the new switch onto the printed-circuit board.
- Bend the 4 retaining lugs back to their original positions.

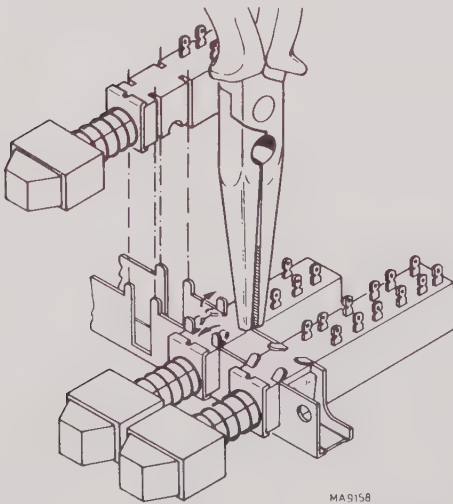


Fig. 9.6. Replacing a switch-segment of a push-button set

Note:

Before a pushbutton switch is refitted to the front panel, it is advisable to stick the two parts of the clamping device together by means of adhesive tape or non-hardening glue, in order to facilitate replacement, refer to fig. 9.5.

9.6. RECALIBRATION AFTER REPAIR

After any electrical component has been replaced the calibration of that particular circuit should be checked, as well as the calibration of other closely related circuits.

Since the power supply affects all circuits, calibration of the entire instrument should be checked if work has been done on the power supply.

9.7. INSTRUMENT REPACKING

If the instrument is to be shipped to a Service Centre for service or repair, attach a tag showing owner (with address) and the name of an individual at your firm who can be contacted. The Service Centre needs the complete instrument serial number and a fault description. Save and re-use the packing in which your instrument was shipped. If the original packing is unfit for use or not available, repack the instrument in such a way that no damage occurs during transport.

9.8. TROUBLE-SHOOTING (General)**9.8.1. Introduction**

The following information is provided to facilitate trouble-shooting. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is helpful in locating troubles, particularly where integrated circuits are used. Refer to the Circuit Description section for this information.

9.8.2. Trouble-shooting hints

If a fault appears, the following test sequence can be used to find the defective circuit part:

- Check if the settings of the controls of the oscilloscope are correct. Consult the operating instructions in this manual (Section 3)
- Check the equipment to which the oscilloscope is connected and the interconnection cables.
- Check if the oscilloscope is well-calibrated. If not, refer to section 8 (checking and adjusting).
- Visually check the part of the oscilloscope in which the fault is suspected. In this way, it is possible to find faults such as bad soldering connections, bad interconnection plugs and wires, damaged components or transistors and IC s that are not correctly plugged into their sockets.
- Location of the circuit part in which the fault is suspected: the symptom often indicates this part of the circuit. If the power supply is defective the symptom will appear in several circuit parts.

After having carried out the previous steps, individual components in the suspected circuit parts must be examined:

- Transistors and diodes. Check the voltage between base and emitter (0,7 Volt approx. in conductive state) and the voltage between collector and emitter (0,2 Volt approx. in saturation) with a voltmeter or oscilloscope. When removed from the p.c.b. it is possible to test the transistor with an ohmmeter since the base/emitter and base/collector junctions can be regarded as diodes. Like a normal diode, the resistance is very high in one direction and low in the other

direction. When measuring take care that the current from the ohmmeter does not damage the component under test.

Replace the suspected component by a new one if you are sure that the circuit is not in such a condition that the new one will be damaged.

- Integrated circuits. In circuit testing can be done with an oscilloscope or voltmeter. A good knowledge of the circuit part under test is essential. Therefore first read the circuit description in section 3.
- Capacitors. Leakage can be traced with an ohmmeter adjusted to the highest resistance range. When testing take care of polarity and maximum allowed voltage. An open capacitor can be checked if the response for AC signals is observed. Also a capacitance meter can be used: compare the measured value with value and tolerance indicated in the parts list.
- Resistors. Can be checked with an ohmmeter after having unsoldered one side of the resistor from the p.c.b. Compare the measured value with value and tolerance indicated in the parts list.
- Coils and transformers. An ohmmeter can be used for tracing an open circuit. Shorted or partially shorted windings can be found by checking the wave-form response when HF signals are passed through the circuit. Also an inductance meter can be used.

Note:

If a component must be replaced always use a direct-replacement. If not available use an equivalent after carefully checking that it does not degrade the instrument's performance. See also section 6.2. (replacement).

After replacement of a component the calibration of the instrument may be affected due to component tolerances. If necessary do the required adjustments.

9.9. REPLACING THE CARRYING HANDLE

1. Remove the upper and lower cabinet plates
2. Remove the plastic strip which is snapped on to the grip.
3. Remove the four screws which secure the grip to the brackets (these screws have been locked with a sealing varnish).
4. Depress the pushbuttons in the brackets and turn the carrying handle as far as possible to the upper side of the oscilloscope.
5. Keep the pushbutton of the right-hand bracket depressed and pull the bracket from its bearing ¹⁾.
6. Remove the grip from the remaining bracket.
7. Depress the pushbutton of the left-hand bracket and turn the latter as far as possible to the lower side of the instrument.
8. Keep the pushbutton depressed and pull the bracket from its bearing.
If it is impossible to remove the left-hand bracket in this way, remove also its bearing in a similar way as described in footnote ¹⁾.

¹⁾ With some instruments it may be impossible to remove the handle in the described way. This is due to an extra securing plate in the right-hand bearing. In that case, DO NOT USE FORCE, but work in accordance with the following procedure which replaces points 3, 4 and 5.

3. Remove the two screws which secure the grip to the right-hand bracket.
4. Remove the two hexagonal bolts which secure the right-hand bearing to the side strip.
5. Depress the pushbutton of the right-hand bracket and take the bearing from the bracket.

9.10. REPLACING THE CATHODE RAY TUBE (CRT)

Warning:

Handle the CRT carefully. Rough handling or scratching can cause the CRT to implode. In particular be very careful with the side connections of the CRT. If these pins are bent the CRT is likely to develop a loss of vacuum.

- Remove the top, bottom and rear covers.
- Remove the black metal screening plate, that covers the Z-amplifier, focus unit, additional power supply and EHT-multiplier.
- Remove the screen bezel by pulling the lower edge.
- Slacken the two screws that secure the support for the graticule illumination lamps.
- Carefully remove the CRT-socket.
- Slacken the brace round the CRT-neck.
- Disconnect the EHT-cable from the EHT unit after unscrewing the swivel nut and discharge the cable to the instrument earth.
- Unsolder the screening wire of the EHT-cable.
- Disconnect the trace rotation wires from the auxiliary unit.
- Carefully unplug the side connections of the CRT.
- Carefully withdraw the CRT through the front panel of the instrument.
- If the rubber sleeve around the neck of the CRT needs to be slid over the neck of a replacement tube, the use of industrial talcum powder is strongly recommended, to prevent the rubber sleeve from sticking on the CRT neck.

9.11. REMOVING THE PRINTED CIRCUIT BOARDS (UNITS)

Removal of unit 12, 4, 7, 9, 8, 26, 11 and 24.

Next units can be easily removed after disconnecting the various wires and plugs and removing the appropriate mounting screws.

- | | |
|---------------------------|------------|
| – Intermediate amplifier | (unit 12) |
| – Delay line | (unit 4) |
| – Focus unit | (unit 7) |
| – Trigger amplifier | (unit 9) |
| – Time-base unit | (unit 8) |
| – Final-X amplifier | (unit 26) |
| – Z-amplifier | (unit 11) |
| – Additional power supply | (unit 24)* |

Warning: The shielding of the c.r.t.'s e.h.t. cable is grounded via one of the mounting screws, of the additional power supply unit.

Do not switch on the instrument with this ground connection hanging loose !

Remaining units can be removed as indicated in the following.

Input attenuator assembly (unit 2)

- Remove the cabinet top and bottom plates.
- Remove the shielding plate at the bottom side of the attenuator (remove 9 screws).
- Unplug the appropriate multipole connectors and coaxial cables.
- Remove the V/DIV attenuator knobs.
- Loosen the μ P and event counter box (remove 5 screws).
This unit need not being disconnected.
- Remove the two Allen-key screws, which clamp the attenuator at the bottom side to the frontpanel.
- Remove the two central nuts which clamp the attenuator to the frontpanel.
- The attenuator unit can be removed by shifting it backwards (carefully lifting away the μ P and event counter box) and have it leaving the instrument via the bottom side.

Power supply unit (unit 5)

- Remove the lower cover plate.
- Remove the rear plate of the instrument (2 screws).
- Remove the black metal screening plate at the bottom side (6 screws).
- Remove the 2 screws which secure the unit to the rear panel.
- Remove the 3 screws which secure the unit to the bottom side of its compartment.
- Unplug the 5 multipole connectors from the unit.
- Disconnect the 2 pole connector to the Focus unit.
- Disconnect the white wire to the E.H.T. unit.
- Disconnect the 2 yellow wires from the transformer on the power supply unit.
- Carefully withdraw the unit out of its compartment.

Final Y amplifier (unit 13)

- Remove the upper cabinet plate.
- Remove the two screws which secure the bracket to the side strip.
- Disconnect the miniature coaxial plugs.
- Unplug the multipole connector.
- Remove the delay-line connections.
- Disconnect the wires from the C.R.T. pins and carefully lift out the circuit board.

E.H.T. unit (unit 15)

- Remove the lower cover plate.
- Remove the black metal screening plate at the bottom side (6 screws).
- Disconnect the E.H.T. cable by unscrewing the swivel nut and pulling the cable out of the E.H.T. unit.
- Carefully discharge the cable.
- Disconnect the white wire from the power supply unit.
- Disconnect the green wire from ground.
- To extract the E.H.T. unit, swivel out by applying slight pressure to one side of this unit.

Trigger source unit (unit 16)

- Remove the cabinet plates.
- Unplug the four multipole connectors.
- Remove the two Allen-key screws that secure the board to the front panel.
- Unscrew the two screws at the rear side of the board.
- Unsolder the wires at the components side of the board.
- Unplug the two miniature coaxial plugs at the soldering side of the board.
- Carefully lift the unit out of the oscilloscope.

Calibration unit (unit 17)

- Pull off the FOCUS and INTENS knobs.
- Remove the lower cabinet plate.
- Unplug the two multipole connectors.
- Disconnect the single wire connectors.
- Unsolder the two LED wires.
- Remove the two screw that secure the board to the front panel.
- Unscrew the screw which secure the board to the side strip.
- Carefully lift the unit out of the oscilloscope.

V.C.O. unit (unit 23)

- Remove the top cover plate.
- Remove the shielding plate of the V.C.O. unit (3 screws).
- Remove the 3 threaded spacers.
- Unsolder the 5 wires to the SET potentiometer assembly.
- Disconnect the flat cable from the Event-counter unit.
- Remove the unit.

LED display unit (unit 21)

- Remove the top cover plate.
- Disconnect the flat cable from the Event-counter unit.
- Remove the 2 mounting nuts.
- Remove the unit.

Microprocessor unit (unit 27)

- Remove the top cover plate.
- Remove the microprocessor unit-shielding plate (two screws).
- Disconnect the flat cable from the Event-counter unit.
- Disconnect D and ΔT wires from the trigger amplifier.
- Disconnect the CLK cable.
- Remove the four mounting screws.
- Remove the unit.

Event-counter unit (unit 28)

- Remove the top cover plate.
- Remove the microprocessor unit-shielding plate.
- Remove the two threaded studs and carefully swing up the microprocessor and event-count assembly from the screening box.
- Disconnect the various cables (note the various connections for convenient reconnections later-on !).
- Remove the four mounting screws.
- Remove the unit.

9.12. TEST AND REPAIR HINTS FOR MICRO-COMPUTER SECTION

9.12.1. Introduction

The ROM memory which is in the micro-processor circuit contains except the normal working program also a test program.

This test program consists of so-called:

- Non-selectable tests
- Selectable tests

Non-selectable tests

These tests are included in the start procedure of the normal working program. They are the so-called power-on tests.

These tests are automatically carried-out every time the instrument is switched on.

These tests include:

- Processor test
- PROM test
- RAM test
- Display test.

Selectable tests

These are stand-alone test routines. To initiate these tests a pair of switches located on the μ P p.c. unit must be put in the test position.

(one switch selects the test mode;
the other one inhibits the watchdog

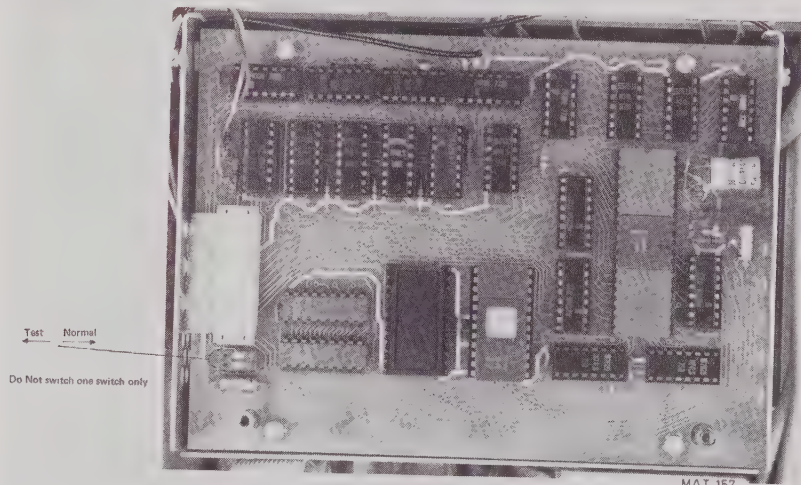


Fig. 9.7. Location of Service mode switch on microprocessor unit (unit 27)

In this mode the desired test can be selected with the SET knob.

The LED display shows successively the word TEST with number 0 ... 4.

Each TEST number remains on the display during approx. 1 sec.

If during the test number indication the SET knob is pressed, that specific test has been selected.

- TEST 0 = Static display test
- TEST 1 = Event counter Load/End test
- TEST 2 = Delay counter End test
- TEST 3 = Bus High test
- TEST 4 = Bus Low test.

Note: If the circuit is in the test mode when switching-on, also the power-on test is executed.

If TEST 3 or TEST 4 has been selected the only way to get out-of these tests is temporary switching-off the mains voltage.

There are two display tests, one in the power-on routine showing a $\overline{H}$ in each digit for half a second successively and one in the test mode (TEST 0) which gives a stable $\overline{H}$ display.

9.12.2. Power on tests

Processor test

A few instructions are executed to test whether the processor is in working condition. If so a  is shown in the right most digit of the display. (only for a short moment because the processor proceeds with the next test).

PROM test

The PROM's checksum is calculated from the PROM's contents and compared with the stored checksum. If no error is found a  is shown in the right-most digit of the display (only for a short moment because the processor proceeds with the next test).

RAM test

The RAM storage capability is checked by writing certain test patterns in all RAM addresses and reading them again.

If an error is found the error byte is addressed permanently, and the  remains in the display.

Display test

Each digit in the display is showing an  for half a second.

At the end also the three LED's next to the LED display light up for half a second.

This completes the power-on tests.

9.12.3. Service tests

Following tests are selectable when the switch on the microprocessor unit has been put in the service (test) mode. (See fig. 9.7.).

9.12.3.1. TEST 0 *Display test*

If the SET knob is pressed at the moment that the LED display shows TEST 0 the left most digit of the display shows an .

After pressing again the SET knob digit lights up and so on.

Do not press the SET knob too shortly because then nothing happens.

Also the three led's next to the LED display are checked.

In this test the display unit can be checked.

9.12.3.2. TEST 1 *Event counter load/end test*

If the SET knob is pressed at the moment that the LED display shows TEST 1 the Event counter load/end test is initiated.

This test is divided in seven test patterns which are selected by successively pushing the SET knob.

The test number is indicated in the LED display.

This test is a help for checking the latches and counters in the event counter circuit.

In this test certain bit patterns are loaded into latches D2413 ... D2418.

Patterns 1 and 2 serve to test these latches.

Patterns 3 7 serve to check the counters and the "Count-ready" decoding circuits.

Patterns 1 and 2

Patterns of alternate 1's and 0's are loaded into the latches and can be checked on the latches outputs. (A logic probe can be used).

— *Pattern 1*

A bit pattern of AAAAA (Hexadecimal) is loaded into the latches.

The levels on the outputs of the latches must be:

	D2413 ... D2417	D2418
point 9	1	0
point 10	0	1
point 15	1	0
point 16	0	1

– *Pattern 2*

A bit pattern of 55555 (Hexadecimal) is loaded into the latches.
The levels on the outputs of the latches must be:

	D2413 ... D2417	D2418
point 9	0	1
point 10	1	0
point 15	0	1
point 16	1	0

Patterns 3, 4, 5, 6 and 7

In these test various bit patterns are applied to the latches so that the corresponding number of pulses to be counted have a successively ratio of approx. 10:1.

The number of pulses to be counted is the 9-complement of the bit pattern applied to the latches.

In these tests the ripple count outputs and the min/max outputs of the counters can be checked.

After counting the number of pulses, the "count ready" pulse (p.14 of D2419) goes from "1" to "0" and remains "0" until the beginning of the hold-off pulse.

Above signals can be measured with the oscilloscope itself or another one.

Use the end edge (which is negative going) of the hold-off signal which is present on p.10 or p.12 of D2401 as trigger source.

- Set the beginning of the MTB sweep at the first vertical graticule line.
- Apply an Y-signal of 1 MHz.
- Select the TRIG mode.
- Set the MTB TIME/DIV switch so that the number of events to be counted remains within the 10 divisions MTB sweep.

– *Pattern 3*

Latches input bit pattern: 09990 (Hexadecimal).

Corresponding number of pulses to be counted: 90009.

Set the MTB TIME/DIV switch to 10 ms/DIV and check that the DTB starts at the end of the 9th division.

– *Pattern 4*

Latches input bit pattern: 90004 (Hexadecimal).

Corresponding number of pulses to be counted: 9995.

Set the MTB TIME/DIV switch to 1 ms/DIV and check that the DTB starts at the end of the 10th division.

– *Pattern 5*

Latches input bit pattern: 99008 (Hexadecimal).

Corresponding number of pulses to be counted: 991.

Set the MTB TIME/DIV switch to 0,1 ms/DIV and check that the DTB starts at the end of the 10th division.

– *Pattern 6*

Latches input bit pattern: 99904 (Hexadecimal).

Corresponding number of pulses to be counted: 95.

Set the MTB TIME/DIV switch to 10 μ s/DIV and check that the DTB starts in the middle of the 9th division.

– *Pattern 7*

Latches input bit pattern: 99998 (Hexadecimal).

Corresponding number of pulses to be counted: 1.

Set the MTB TIME/DIV switch to 1 μ s/DIV and check that the DTB starts at the beginning of the 2nd division (so after 1 counting pulse).

9.12.3.3. TEST 2 Delay counter end test

If the SET knob is pressed at the moment that the LED display shows TEST 2, the delay counter end test is initiated.

This test is divided in four test patterns which are selected by successively pressing the SET knob. The test number is indicated in the LED display.

This test is a help for checking the counters and corresponding logic circuits in the dual d.a.c. circuit (these circuits are located on the microprocessor p.c. board).

In this test certain bit patterns are loaded into the counters D2601 ... D2604.

The status of the corresponding outputs is given in the following table.

Except for the D2604 outputs in pattern 1 a logic probe can be used.

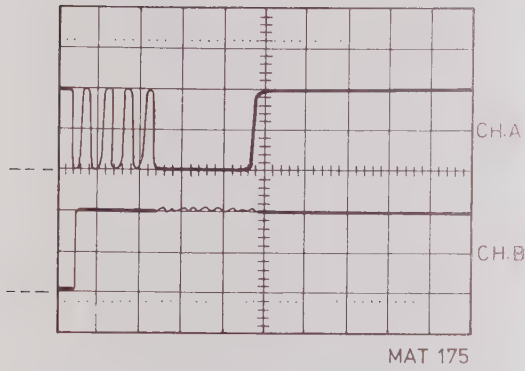
The D2604 outputs in pattern 1 must be checked with a two channel oscilloscope.

This oscilloscope must be triggered with the LOAD 2 signal, applied to channel B.

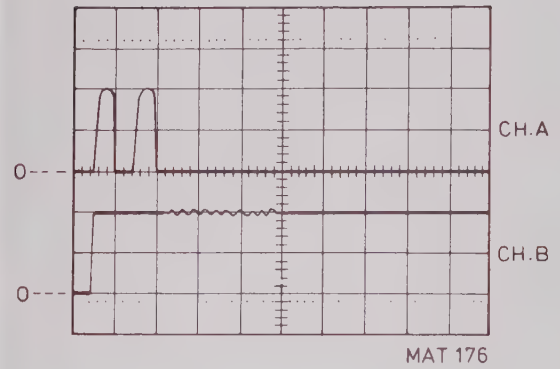
Set the MTB TIME/DIV switch to 2 μ s/DIV and the ch. A and ch. B AMPL/DIV switches to 2 V/DIV.

The signal at the outputs of D2604, applied to channel A are shown in fig. 9.8.

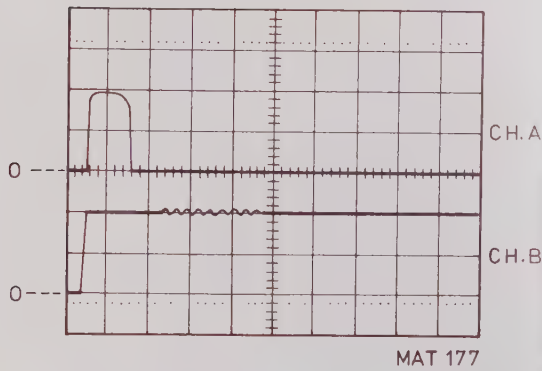
		Pattern 1	Pattern 2	Pattern 3	Pattern 4
Applied bit-pattern (Hexadecimal)		C009	3999	A000	4000
D2601	— p.3	0	1	0	0
	p.2	0	1	1	0
	p.6	1	0	0	1
	p.7	1	0	1	0
D2602	— p.3	0	1	0	0
	p.2	0	0	0	0
	p.6	0	0	0	0
	p.7	0	1	0	0
D2603	— p.3	0	1	0	0
	p.2	0	0	0	0
	p.6	0	0	0	0
	p.7	0	1	0	0
D2604	— p.3		1	0	0
	p.2	See	0	0	0
	p.6	text	0	0	0
	p.7		1	0	0



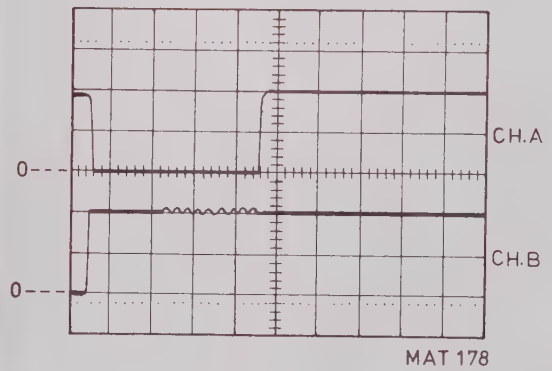
D2604 pin 3.



D2604 pin 2

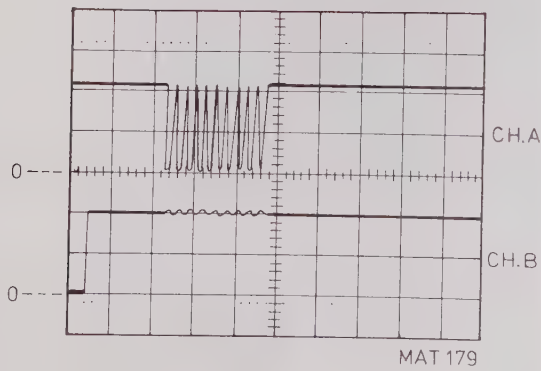


D2604 pin 6.



D2604 pin 7.

Fig. 9.8. D2604 output signals pattern 1



D2607 p 6,8

Fig. 9.9. Terminal count signal (T.C.) pattern 1

Fig. 9.9. shows the Terminal Count signal at points 6 and 8 of D2607 in pattern 1. During patterns 2 and 3 these points are continuously "0"; in pattern 4 the clock signal is present at these points.

9.12.3.4. TEST 3 *Bus-high test*

If the SET knob is pressed at the moment that the LED display shows TEST 3, the Bus-high test is initiated. In this test all address-and data lines are high during the write-cycle of the micro-processor. Use the WR output of the micro-processor for triggering. With this test also the circuits close to the micro-processor circuit can be checked.

- NOTE:** — Due to the fact that all "1" 's are written the LED display cannot show the test number but remains dark.
- Pressing the SET knob has no further effect. The only way to get out of this test is to switch off the mains switch for a moment.

9.12.3.5. TEST 4 *Bus-low test*

If the SET knob is pressed at the moment that the LED display shows TEST 4 the Bus-low test is initiated. This test is identical to TEST 3 except that now all address and data lines are low during the write-cycle of the microprocessor. Also escaping from this test is only possible by switching off the mains for a short moment.

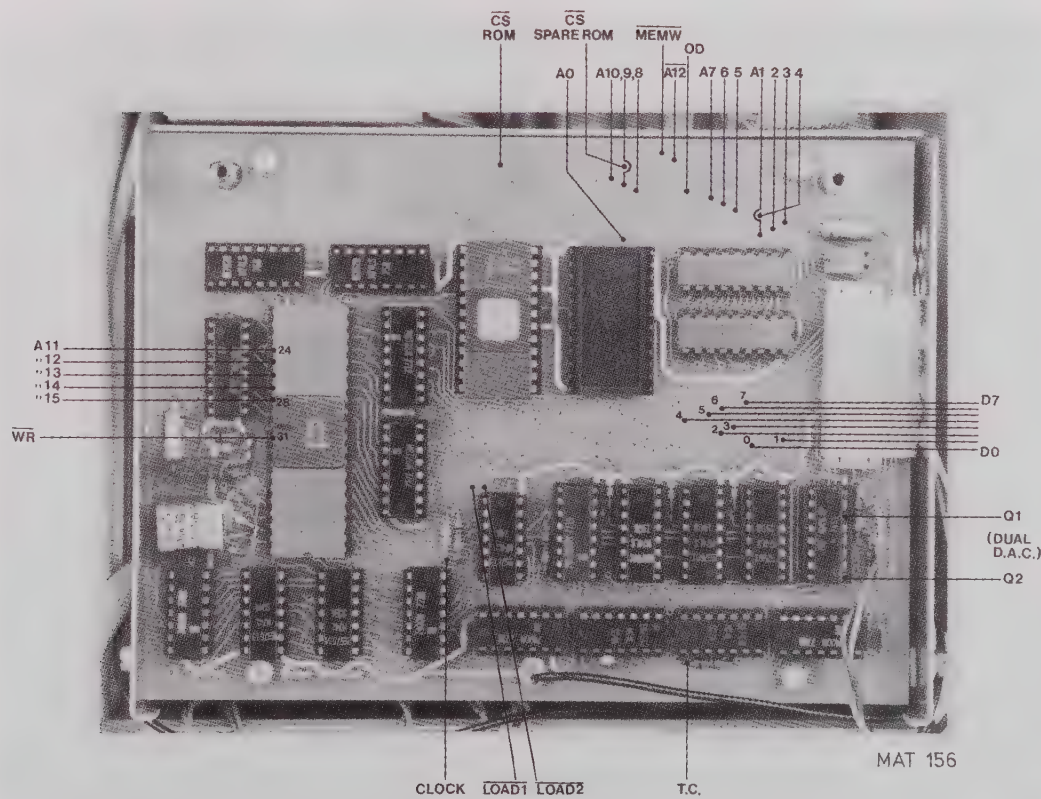


Fig. 9.10. Microprocessor printed circuit board

10. INTRODUCTION TO MICROPROCESSORS

10.1. A BRIEF ENCOUNTER

Microcomputers, like people, do not reveal all their secrets at a brief encounter. If this is your first introduction to a microcomputer, you will need a little time to familiarise yourself with its characteristics — what it can do, how it does it and how its facilities are best used to advantage.

As its name implies, a microcomputer is an extremely small device.
Extremely small because it is based on a silicon-chip microprocessor.

The great future predicted for the microprocessor lies in its *enormous work capacity* for processing signals, available within *negligible physical capacity*.

The human brain has the ability to determine by calculation in a more sophisticated way, but our micro-computer, with its built-in 'one-track' mind, is capable of much faster calculation speeds. Also the computer facilities extend beyond the confines of the brain and memory to perform some of the functions we allocate to other parts — the eyes, ears, arms and legs.

Besides the ability to store and manipulate information, the microprocessor circuits are capable of recognising visual, aural and physical conditions, evaluating them and presenting them in a form required by an instrument or operator. A practical application of this could be the monitoring of strain-gauges or thermometers in an industrial process at regular intervals and the recording of the values, together with any alarm conditions, on a print-out. In contrast to this data logging function, the microcomputer could be an integral part of a laboratory measuring instrument

Microcomputers are designed with built-in flexibility to enable them to be used for a wide variety of applications. This versatility is obtained in the signal conditioning circuits that present the data to the computer central processing unit in a form that it can readily understand. In electronics, the simplest and most reliably defined condition is when a circuit is either switched on or switched off. This two-state notation of defining the numerical terms of a problem is universally used in computers and is known as the binary system.

10.2. COMING TO TERMS

After a general picture of the microcomputer field, it is useful to look a little closer at the practical aspects and to discuss some of the terms that are in everyday use.

Microcomputer	A miniature electronic system that performs arithmetic and logic operations on data according to a programmed sequence of instructions stored in a memory. As a calculating system, the microcomputer consists not only of the physical components (the hardware) but also of program instructions (the software).
Hardware	The mechanical, electronic and electromechanical components of the computer system.
Software	The programmer's language for communicating with the computer. This includes sets of programs translated into binary form to enable the computer to perform specific functions as required by the system user.

Microprocessor CPU	The heart of the microcomputer, the central processing unit (CPU) that performs all the functions as arithmetic and logic operations that are written in the system software program. In addition to the Arithmetic and Logic Unit (ALU) it also contains a Control Block and Register Array.
Memory	A high-speed electronic device in which data and instructions are stored for subsequent processing.
Input/Output	Devices that provide communication between the microcomputer system and the outside world. For example, interfacing input data and instructions via a keyboard and outputting results via a display unit or printer.
Instruction set	A set of characters that define an operation with generally one or more addresses, which are given via the input device and can be stored in the memory. When a program is running, data-words are processed in a sequence and manner as specified by the instructions, the results being stored and/or outputted via an output device.
Data word	A word, or group of binary digits (bits) used to encode data, as distinct from an instruction word. A byte is a word of 8 bits.
Binary notation	A system of numbering used in computers that uses 2 as a base in contrast with the normally used decimal system that has 10 as a base. Only two symbols are required in the binary system, 0 and 1, which can be conveniently represented in electronic circuits as two voltage levels in a signal. The binary equivalents of the decimal numbers 0 to 10 are as follows:

DECIMAL		BINARY
0	=	0000
1	=	0001
2	=	0010
3	=	0011
4	=	0100
5	=	0101
6	=	0110
7	=	0111
8	=	1000
9	=	1001
10	=	1010

Addition:

DECIMAL	BINARY
5	0101
+9	+1001
14	1110

To add binary numbers, proceed as in decimal but remember that the radix is 2. i.e. carry 1 when 2 is reached.

Hexadecimal notation

Using 16 as a base this system provides a short-band method of writing 4-bit binary numbers with alphanumeric symbols. This is useful for a data-word grouped as a 4-bit field, where there are 16 combinations.

COMBINATION	BINARY CODE	HEXADECIMAL CODE
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

Analog-to-Digital Converter

Enables physical or electrical input signals that are in analog form to be converted to digital form for processing in the computer.

Register

Consists of a group of two-state flip-flops, which by means of a clock-pulse command can store the data-word present on its input lines. The output lines remain stable until a new data-word is clocked into the register. A group of registers forms a memory.

Data-bus

Enables several circuits to communicate with each other without the need for separate data paths. This databus is common to all circuits and a timing and control circuit organises which circuits use the databus at any particular time, in conjunction with an ADDRESS-BUS and a CONTROL-BUS.

Address-bus

Enables memory locations to be addressed by their unique device numbers.

Control-bus

Controls the exact timing of the communication on the data-bus and also the direction of data flow.

10.3. SYSTEM FEATURES

With a basic understanding of the language and hardware component parts of a microcomputer it is interesting to discover how these can be integrated to form an organised system. The following illustrations show the basic system features which, for greater comprehension, should be studied with reference to the computer terms that have been previously defined.

Basic features

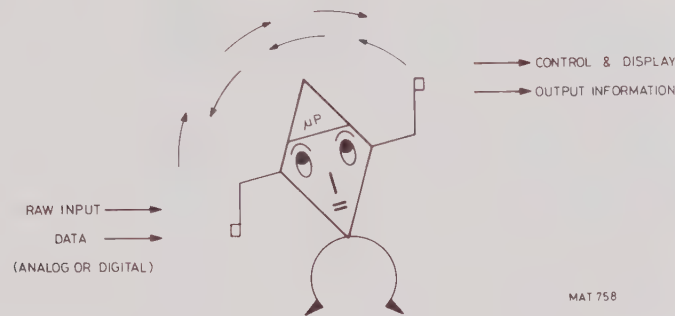


Fig. 10.1.

In simple terms, our Master Microcomputer takes data with one hand, juggles with it, and hands it out with the other. Being highly intelligent, its right hand definitely knows what its left hand is doing!

Input features

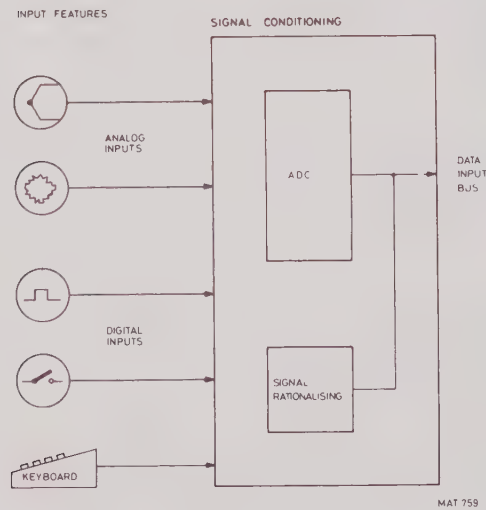
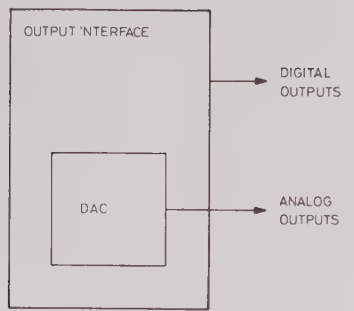


Fig. 10.2.

The raw inputs from analog sources such as thermocouples, strain-gauges voltage and current devices, etc., must first be converted to the digital form required by an ADC in the signal conditioning part of the microcomputer. Digital inputs from switch contacts, logic levels from sold-state devices or from counters, etc., must be converted to the correct logic levels within the signal conditioning part.

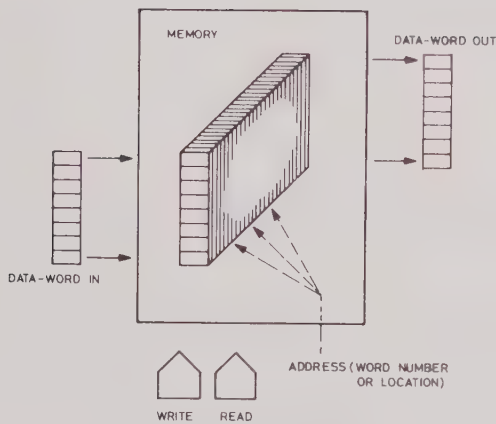
Output features



MAT 760

Fig. 10.3.

Memory features



MAT 761

Fig. 10.4.

The output interface circuits are designed to present the output data in a form suitable for the various system requirements, e.g. digital displays, print-outs, parallel and serial interfaces, alarms, etc. When analog output signals are required, digital-to-analog conversion (DAC) is performed in the computer output interface circuits.

A memory is simply a group of registers used for storing data-words, for future retrieval when required. With a WRITE pulse, a data-word can be stored; a READ pulse enables a data-word to be read out of a location. An ADDRESS must be provided with the READ and WRITE pulses to locate the specified data-word. Memories can be used for storing signal data or for programming instructions. Instruction sets for microcomputers are usually stored in read-only memories, ROMs or PROMs (Program Read Only Memories).

The memory contains not only the information to tell the microprocessor what to do, but also the instructions on how to do it. Variable data are usually stored in random-access memories, RAMs.

Microprocessor features

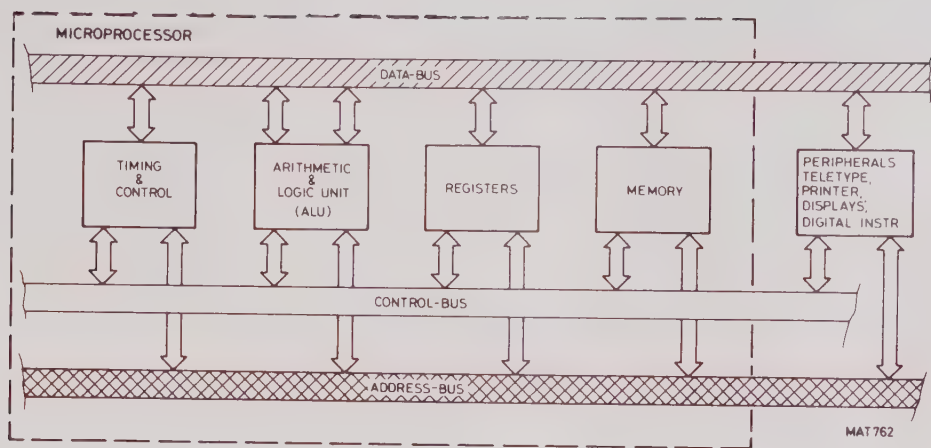


Fig. 10.5.

The elementary circuits of a microcomputer comprise:

- registers
- a memory (ROM + RAM)
- a data-bus, control-bus and address-bus
- a data-bus, timer and controller circuit
- an arithmetic and logic unit (ALU)

If the integrated circuit contains no memory, or only a limited memory, we refer to this as a microprocessor. The microcomputer, together with its memory and the peripheral equipment constitute the hardware of the system.

Programming features

In order to perform meaningful operations with the hardware of a computer system, we need to specify precisely:

- what OPERATIONS are required upon a defined DATA-WORD
- in what SEQUENCE these will occur
- to which LOCATION the results of the operation have to be deposited.

This process of prescribing the necessary actions within a computer system is called PROGRAMMING the computer software.

Programming consists of the sequential execution of the instructions stored in the memory, under the control of the TIMING and CONTROL part. Its circuits decode the instruction and initiate the necessary data-word transports and operations.

A basic flow-chart cycle for each instruction is as follows:

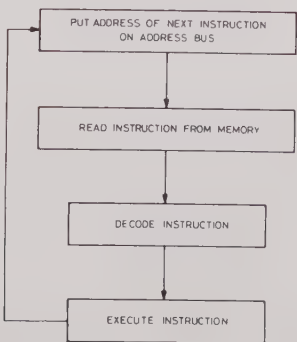


Fig. 10.6.

A PROGRAM COUNTER is a special register equipped to increment the address of sequential instructions to enable new instructions to be FETCHED from the memory. As the program counter is connected to the data-bus, the contents can be replaced by other values to permit a JUMP to an instruction elsewhere in the memory.

As the execution of an instruction consists of a number of sub-steps, it is useful to be able to store an instruction temporarily in a register if the next operation needs to use this result. The two operations are combined in a single register, called the ACCUMULATOR for ease of presentation to the ALU in the next instruction.

Apart from the memory, microcomputers usually have some general-purpose registers to store intermediate results on a temporary basis.

Note: For more information refer to:

"INTRODUCTION TO MICROPROCESSORS AND THEIR USE IN T&M INSTRUMENTS".

Ordering number: 9499 990 00711.

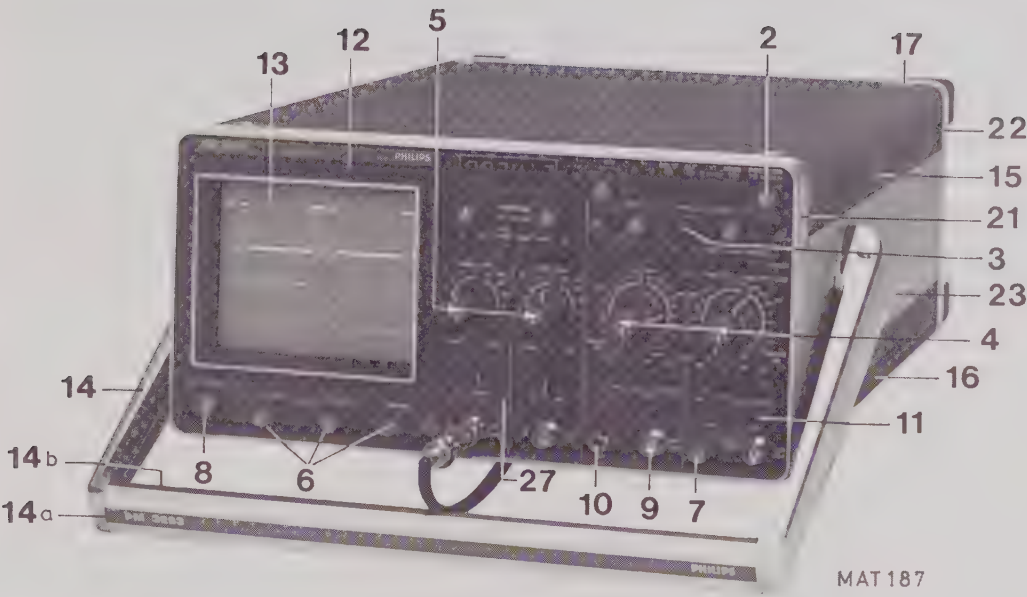


Fig. 11.1. Front view showing item numbers

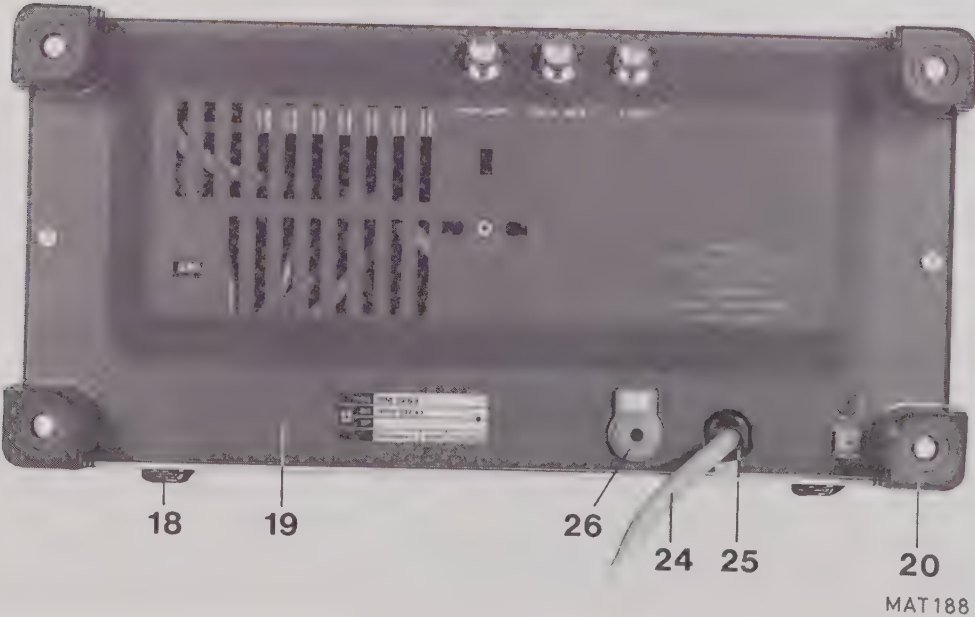


Fig. 11.2. Rear view showing item numbers

11. PARTS LIST
(Subject to alteration without notice)

11.1. MECHANICAL PARTS (see Fig. 11.1. and 11.2.)

Item	Qty.	Order number	Description	Used for:	
2	5	5322 414 34091	Knob, dia 10 mm, shaft dia 4 mm } Cover, grey with dash	R1/S24 R2/S3 R3/S4	SET (Down-stop- Up) POSITION, TB MAGN POSITION, PULL TO INVERT A
2	5	5322 414 74015		R4/S5 R5/S6 R7/S7	POSITION, PULL TO INVERT B LEVEL/SLOPE DTB LEVEL/SLOPE MTB
3	1	5322 414 34217	Knob, dia 6, 7-10 mm, shaft dia 4 mm } Clamping spring	R6	TRACE SEPARATION
3	1	5322 492 64337			
4	2	5322 414 34081	Knob, dia 24 mm, shaft dia 6 mm } Knob, dia 14 mm, shaft dia 4 mm } Cover, blue with dash	S13/R10/S14	TIME/DIV DTB
4	2	5322 414 34119		S15/R11/S16	TIME/DIV MTB
4	2	5322 414 74016			
5	2	5322 414 34079	Knob, dia 18,7 mm, shaft dia 6 mm } Knob, dia 10 mm, shaft dia 4 mm } Cover, blue with dash	S9/R8/S10 S11/R9/S12	AMPL/DIV A AMPL/DIV B
5	2	5322 414 34091			
5	2	5322 414 74029			
6	3	5322 414 34134	Knob, dia 10 mm } Clamping spring } Cover, grey with dash	R14/S24 R16 R17	ILLUM/POWER ON-OFF INTENS FOCUS
6	3	5322 492 64337			
6	3	5322 414 74015			
7	1	5322 414 34091	Knob, dia 10 mm, shaft dia 4 mm } Skirt } Cover, grey with dash	R18	X-AMPL/HOLD OFF
7	1	5322 414 74028			
7	1	5322 414 74015			
8	1	5322 267 14014	Socket } Plastic nut } Current loop } BNC adapter for CAL socket	X1/X2	CAL
8	1	5322 505 14184			
8	1	5322 405 94073			
—	1	5322 263 54003			
9	5	5322 267 10004	BNC socket	X3 X4 X6 X7	A input B input DTB EXT TRIG. input MTB EXT TRIG. or X DEFL input
				X8 X9 X10 X5	MTB gate output DTB Gate output Z-MOD input
10	1	5322 535 80523	Earth socket		
10	1	5322 505 14178	Serrated nut		

<i>Item</i>	<i>Qty.</i>	<i>Order number</i>	<i>Description</i>	<i>Used for:</i>
11	34	5322 414 14011	Knob	Push-button switches
12	1	5322 466 74059	Bezel	
13	1	5322 480 34046	Contrast filter, grey	
13	1	5322 480 34074	Contrast filter, blue	
14	1	5322 498 54082	Set grip and brackets	Carrying handle
14a	1	5322 455 84077	Strip with type nr. (blue)	
14b	1	5322 460 64044	Explanatory strip english	
—	1	5322 447 94169	Front cover, complete	
15	1	5322 447 94482	Upper cabinet plate, complete	
16	1	5322 447 94483	Lower cabinet plate, complete	
17	4	5322 417 24024	Quick fastener, complete	Cabinet plates
18	4	5322 462 44297	Rubber foot	Lower cabinet plate
19	1	5322 447 94524	Rear cabinet plate	
20	4	5322 462 44154	Nylon foot, complete	Rear side
21	1	5322 447 94143	Cast aluminium front plate	
22	1	5322 447 94504	Cast aluminium rear plate	
23	1	5322 460 64042	Aluminium side strip left	Cabinet
23	1	5322 460 64043	Aluminium side strip right	Cabinet
—	8	4822 502 30047	Screw	Aluminium side strip
—	—	4822 505 10029	Square nut M3	In aluminium side strip
24	1	5322 321 14066	Mains cable	
25	1	5322 325 64061	Cable cleat	Fixing the cable in the rear plate
—	1	4822 253 30025	Fuse, 2A slow blow	Mains fuse
26	1	5322 256 34081	Fuseholder	
—	—	5322 255 44088	Holder for LED	
—	2	5322 255 24015	Lampholder	Graticule illumination
—	6	5322 405 94074	Male clamping piece	} Fixture for push button Switch assy's
—	6	5322 405 94075	Female clamping piece	
—	6	4822 502 11142	Screw M3X20	
—	—	5322 405 94171	Complete set of clamping pieces	
—	4	5322 462 44153	Rubber clamping buffer	C.R.T. front
—	1	5322 535 94656	Plastic spindle	R14 ILLUM
—	1	5322 532 24389	Coupling piece	
—	2	5322 501 14013	Special nut	Attenuator switch
—	—	5322 395 54023	Tool	Special attenuator nut
—	4	5322 505 14186	Special nut	LEVEL/SLOPE and POSITION potentiometers
—	—	5322 395 54024	Tool	Above mentioned special nut
—	—	5322 276 14158	Single push-button switch	
—	—	5322 320 14102	Set of coaxial cables	
—	—	5322 268 24116	Coaxial socket, vertically mounted on p.c. boards	
—	—	5322 268 14141	Contact pin for coax. socket	
27	1	5322 455 84076	Textplate PM 3263	Front panel
—	—	4822 390 20023	Grease (Dow Corning "4 Compound" Silicon Dielectric; MIL.S.8660B)	EHT connector
—	—	5322 390 34006	Coating (Dow Corning 3140 RTV coating)	FOCUS unit
—	—	4822 266 30071	3-pole plug (Stocko MKF 803-1-0-303)	
—	—	4822 265 30121	3-pole socket (Stocko MKS 823-1-0-303)	
—	—	4822 266 30072	4-pole plug (Stocko MKF 804-1-0-404)	
—	—	4822 265 30119	4-pole socket (Stocko MKS 824-1-0-404)	
—	—	4822 266 30073	6-pole plug (Stocko MKF 806-1-0-606)	
—	—	4822 265 30117	6-pole socket (Stocko MKS 826-1-0-606)	
—	—	4822 266 40057	7-pole plug (Stocko MKF 807-1-0-707)	
—	—	4822 265 40119	7-pole socket (Stocko MKS 827-1-0-707)	

Qty	Order number	Description	Used for
6	5322 276 14101	Dual change-over switch with spring for use with a reset bar.	Vertical display mode switch S1.
1	5322 278 74007	Reset bar for maximal 6 switches. Must be sawn to the required size. When doing this take care that the distance between end of bar and last stud is exactly 4,1 mm.	
1	5322 405 94181	Support for maximal 13 switches: must be sawn to the required size.	
4	5322 276 14101	Dual change-over switch with spring for use with a reset bar.	Horizontal display mode switch S2.
1	5322 278 74007	Reset bar for maximal 6 switches. Must be sawn to the required size. When doing this take care that the distance between end of bar and last stud is exactly 4,1 mm.	
1	5322 405 94181	Support for maximal 13 switches: must be sawn to the required size.	
2	5322 276 14101	Dual change-over switch with spring for use with a reset bar.	Push-button switch S8, S25/26/27/28.
2	5322 276 14158	Dual change-over switch with spring for use with a reset bar. Switch has long axis at the rear for use with security system.	
3	5322 276 14117	Dual change-over switch with spring for use with a reset bar. Push-on push-off type.	
1	5322 405 94181	Support for maximal 13 switches: must be sawn to the required size.	
1	5322 276 44083	Security system for maximal 5 switches. Avoids that more than one switch is depressed at a time.	
1	5322 276 14359	Dual change-over switch with spring for use with a reset bar. Release key for single shot function.	
16	5322 276 14101	Dual change-over switch with spring for use with a reset bar.	Selection switches for triggering S19/20/21/22.
4	5322 278 74007	Reset bar for maximal 6 switches. Must be sawn to the required size. When doing this take care that the distance between end of bar and last stud is exactly 4,1 mm.	
2	5322 466 85842	Support for maximal 12 switches: must be sawn to the required size.	
1	5322 273 14057	DTB TIME/DIV switch S13.	Attenuator unit.
1	5322 273 14056	MTB TIME/DIV switch S15.	
1	5322 219 84135	Unit 2, attenuator unit.	
1	5322 216 54202	Printed circuit board.	
2	5322 273 34116	Switch segment S9/S11.	
2	5322 535 94951	Plastic shaft, var. gain.	
1	5322 121 44261	Unit 3, mains filter.	
1	5322 320 44039	Unit 4, delay line.	

1	5322 216 54204	Unit 5, power supply.	Replace R1811 on this unit by a 1,2 Ohm type. For ordering code see parts list.
1	5322 218 64113	Unit 7, focus unit.	
1	5322 216 54205	Unit 8, time-base.	
1	5322 216 54247	Unit 9, trigger amplifier.	
1	5322 216 54246	Filter printed circuit board.	Trigger amplifier.
1	5322 216 54203	Unit 11, Z-amplifier.	
1	5322 216 54304	Unit 12, intermediate amplifier.	
1	5322 216 54197	Unit 13, final Y-amplifier.	
1	5322 219 84132	Unit 15, EHT unit.	
1	5322 216 54248	Unit 16, trigger source selector.	
1	5322 216 54238	Unit 17, calibration generator.	
1	5322 216 54211	Unit 21, display unit.	
1	5322 216 54212	Unit 23, VCO unit.	
1	5322 216 54213	Unit 24, additional power supply.	
1	5322 216 54214	Unit 26, final X-amplifier.	
1	5322 216 54215	Unit 27, microprocessor unit.	
1	5322 216 54216	Unit 28, event counter.	

11.2. ELECTRICAL PARTS

Item numbers (e.g. C ... R V) have been divided in groups which relate to the circuit, the unit and the circuit diagram, according the following table.

Item number	Location	Unit number
1 ... 99	Front or rear plate of the instrument	—
100 ... 199	Y input attenuator and impedance converter	2
200 ... 599	Intermediate amplifier	12
600 ... 699	Final Y amplifier	13
700 ... 799	Ext. input m.t.b.	16
800 ... 899	Trigger circuit m.t.b.	9
900 ... 999	Sweep circuit m.t.b.	8
1000 ... 1099	Time/div. switch m.t.b.	8
1100 ... 1199	Ext. input d.t.b.	16
1200 ... 1299	Trigger circuit d.t.b.	9
1300 ... 1399	Sweep circuit d.t.b.	8
1400 ... 1499	Time/div switch d.t.b.	8
1500 ... 1549	X Deflection selector	8
1550 ... 1599	Voltage stabilisator (T.B. circuitry)	8
1600 ... 1649	Display-mode logic	12
1650 ... 1699	Voltage stabilisator (intermed. ampl)	12
1700 ... 1799	Final X amplifier	8,26
1800 ... 1899	Power supply	5,15, 24
1900 ... 1999	Calibration generator	17
2000 ... 2099	Final Z amplifier	7, 8, 11, 17, 20, 26
2200 ... 2299	Display unit	21, 28
2300 ... 2399	VCO unit	23
2400 ... 2599	Event counter unit	28
2600 ... 2699	Mocroprocessor unit/trigger unit	9,27

Item	Ordering number			Farad	Tol (%)	Volts	Remarks
Capacitors							
C 101	5322	125	54026	3PF	—	400	TRIMMER
C 102	4822	121	40278	22NF ₁	10	400	POLYESTER FOIL
C 103	4822	122	31072	47PF	2	100	CERAMIC PLATE
C 104	5322	125	50048	3,5PF	—	300	TRIMMER
C 106	4822	122	31191	5,6PF	0,25PF	500	CERAMIC PLATE
C 107	5322	125	50051	18PF	—	300	TRIMMER
C 108	5322	122	34105	33PF	10	50	CERAMIC PLATE
C 109	5322	125	50049	10PF	—	300	TRIMMER
C 110	4822	122	31058	15PF	2	100	CERAMIC PLATE
C 111	4822	122	31182	1PF	0,25PF	500	CERAMIC PLATE
C 112	5322	125	50051	18PF	—	300	TRIMMER
C 113	5322	122	34113	39PF	10	50	CERAMIC PLATE
C 114	4822	122	31081	100PF	2	500	CERAMIC PLATE
C 117	5322	122	34098	10NF	20	50	CERAMIC PLATE
C 118	4822	122	30105	1,5PF	0,25PF	100	CERAMIC PLATE
C 119	4822	122	31081	100PF	2	100	CERAMIC PLATE
C 120	4822	122	31038	2,7PF	0,25PF	100	CERAMIC PLATE
C 121	4822	122	31116	2,2NF	-20+80	40	CERAMIC PLATE
C 122	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 123	4822	122	31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 124	5322	124	14069	6,8UF	-20+20	16	ELECTROLYTIC TANTALUM
C 126	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 127	5322	124	14069	6,8UF	-20+20	16	ELECTROLYTIC TANTALUM
C 128	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 151	5322	125	54026	3PF	—	400	TRIMMER
C 152	4822	121	40278	22NF	10	400	POLYESTER FOIL
C 153	4822	122	31072	47PF	2	100	CERAMIC PLATE
C 154	5322	125	50048	3,5PF	—	300	TRIMMER
C 156	4822	122	31191	5,6PF	0,25PF	500	CERAMIC PLATE
C 157	5322	125	50051	18PF	—	300	TRIMMER
C 158	5322	122	34105	33PF	10	50	CERAMIC PLATE
C 159	5322	125	50049	10PF	—	300	TRIMMER
C 160	4822	122	31058	15PF	2	100	CERAMIC PLATE
C 161	4822	122	31182	1PF	0,25PF	500	CERAMIC PLATE
C 162	5322	125	50051	18PF	—	300	TRIMMER
C 163	5322	122	34113	39PF	10	50	CERAMIC PLATE
C 164	4822	122	31081	100PF	2	500	CERAMIC PLATE
C 167	5322	122	34098	10NF	20	50	CERAMIC PLATE
C 168	4822	122	30105	1,5PF	0,25PF	100	CERAMIC PLATE
C 169	4822	122	31081	100PF	2	100	CERAMIC PLATE
C 170	4822	122	31038	2,7PF	0,25PF	100	CERAMIC PLATE
C 171	4822	122	31116	2,2NF	-20+80	40	CERAMIC PLATE
C 172	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 173	4822	122	31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 174	5322	124	14069	6,8UF	-20+20	16	ELECTROLYTIC TANTALUM
C 176	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 177	5322	124	14069	6,8UF	-20+20	16	ELECTROLYTIC TANTALUM
C 178	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 201	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 203	4822	122	31177	470PF	10	100	CERAMIC PLATE
C 204	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 206	4822	122	31063	22PF	2	100	CERAMIC PLATE
C 207	4822	122	30103	22NF	-20+80	40	CERAMIC PLATE
C 208	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 209	4822	122	31063	22PF	2	100	CERAMIC PLATE
C 211	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 212	4822	122	31063	22PF	2	100	CERAMIC PLATE
C 214	4822	122	31063	22PF	2	100	CERAMIC PLATE
C 215	5322	125	50051	18PF	—	300	TRIMMER
C 216	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 217	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 218	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 219	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 220	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 221	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 222	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 223	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 226	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE

C 230	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 231	4822 122 30098	3,9NF	10	100	CERAMIC PLATE
C 232	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 234	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 235	4822 122 31166	560PF	10	100	CERAMIC PLATE
C 236	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 237	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 238	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 239	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 240	4822 122 31166	560PF	10	100	CERAMIC PLATE
C 241	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 242	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 243	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 244	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 247	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 248	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 249	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 251	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 301	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 303	4822 122 31177	470PF	10	100	CERAMIC PLATE
C 304	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 306	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 307	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 308	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 309	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 311	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 312	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 314	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 315	5322 125 50051	18PF	-	300	TRIMMER
C 316	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 317	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 318	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 319	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 320	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 321	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 322	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 323	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 326	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 330	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 331	4822 122 30098	3,9NF	10	100	CERAMIC PLATE
C 332	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 334	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 335	4822 122 31166	560PF	10	100	CERAMIC PLATE
C 336	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 337	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 338	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 339	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 340	4822 122 31166	560PF	10	100	CERAMIC PLATE
C 341	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 342	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 343	4822 121 41161				POLYESTER FOIL
C 344	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 347	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 348	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 349	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 351	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 400	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 401	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 403	4822 122 30113	180PF	10	100	CERAMIC PLATE
C 413	4822 122 30113	180PF	10	100	CERAMIC PLATE
C 414	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 416	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 417	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 418	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 420	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 422	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 450	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 451	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 453	4822 122 30113	180PF	10	100	CERAMIC PLATE
C 463	4822 122 30113	180PF	10	100	CERAMIC PLATE

C 464	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 466	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 467	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 468	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 470	4822	122	31081	100PF	2	100	CERAMIC PLATE
C 471	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 472	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 502	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 503	4822	122	31054	10PF	2	100	CERAMIC PLATE
C 505	4822	122	31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 506	4822	122	31063	22PF	2	100	CERAMIC PLATE
C 507	4822	122	31054	10PF	2	100	CERAMIC PLATE
C 508	4822	122	31063	22PF	2	100	CERAMIC PLATE
C 509	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 511	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 512	4822	122	30104	1PF	0,25PF	100	CERAMIC PLATE
C 513	4822	122	30104	1PF	0,25PF	100	CERAMIC PLATE
C 514	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 515	4822	124	20468	33UF	-10+50	16	ELECTROLYTIC
C 516	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 517	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 518	4822	122	31054	10PF	2	100	CERAMIC PLATE
C 601	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 602	4822	122	31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 603	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 604	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 605	4822	124	20689	68UF	-10+50	16	ELECTROLYTIC
C 606	4822	122	31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 608	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 609	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 611	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 615	4822	122	31058	15PF	2	100	CERAMIC PLATE
C 616	5322	125	50051	18PF	-	300	TRIMMER
C 617	4822	122	30113	180PF	10	100	CERAMIC PLATE
C 618	4822	122	30113	180PF	10	100	CERAMIC PLATE
C 620	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 621	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 622	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 623	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 625	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 626	4822	122	30128	4,7NF	10	100	CERAMIC PLATE
C 628	4822	122	31063	22PF	2	100	CERAMIC PLATE
C 629	4822	122	31063	22PF	2	100	CERAMIC PLATE
C 700	4822	122	31184	1,5PF	0,25PF	500	CERAMIC PLATE
C 701	4822	122	31194	8,2PF	0,25PF	500	CERAMIC PLATE
C 702	5322	122	34094	82PF	2	100	CERAMIC PLATE
C 703	4822	122	31211	100PF	10	500	CERAMIC PLATE
C 704	4822	121	40407	22NF	10	400	POLYESTER FOIL
C 705	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 706	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 707	4822	122	31177	470PF	10	100	CERAMIC PLATE
C 708	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 709	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 710	4822	122	31217	3,9PF	0,25PF	500	CERAMIC PLATE
C 711	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 712	4822	122	30103	22NF	-20+80	40	CERAMIC PLATE
C 713	5322	125	50051	18PF	-	300	TRIMMER
C 714	5322	125	50051	18PF	-	300	TRIMMER
C 716	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 719	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 800	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 801	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 802	5322	124	14064	4,7UF	-20+20	25	ELECTROLYTIC TANTALUM
C 803	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 804	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 805	4822	122	31056	12PF	2	100	CERAMIC PLATE
C 806	4822	122	31081	100PF	2	100	CERAMIC PLATE
C 807	4822	122	31081	100PF	2	100	CERAMIC PLATE
C 808	5322	124	14064	4,7UF	-20+20	25	ELECTROLYTIC TANTALUM
C 809	4822	121	41161	100NF	10	250	POLYESTER FOIL

C 810	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 811	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 812	4822	122	31081	100PF	2	100	CERAMIC PLATE
C 813	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 814	4822	122	31081	100PF	2	100	CERAMIC PLATE
C 816	4822	122	31056	12PF	2	100	CERAMIC PLATE
C 817	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 822	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 823	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 826	4822	122	31056	12PF	2	100	CERAMIC PLATE
C 827	4822	122	30034	470PF	10	100	CERAMIC PLATE
C 832	4822	122	31056	12PF	2	100	CERAMIC PLATE
C 833	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 834	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 836	4822	122	30055	330PF	10	100	CERAMIC PLATE
C 837	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 838	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 839	5322	124	14064	4,7UF	-20+20	25	ELECTROLYTIC TANTALUM
C 840	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 841	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 842	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 843	5322	124	14064	4,7UF	-20+20	25	ELECTROLYTIC TANTALUM
C 844	4822	122	31056	12PF	2	100	CERAMIC PLATE
C 846	4822	124	20689	68UF	-10+50	16	ELECTROLYTIC
C 900	4822	122	31063	22PF	2	100	CERAMIC PLATE
C 901	4822	124	20697	10UF	-10+50	25	ELECTROLYTIC
C 903	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 904	4822	124	20697	10UF	-10+50	25	ELECTROLYTIC
C 907	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 908	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 909	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 911	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 912	5322	121	40224	4,7UF	10	100	POLYESTER FOIL
C 913	5322	121	54108	47NF	1	63	POLYSTYRENE FOIL
C 914	5322	121	54062	4,3NF	1	63	POLYSTYRENE FOIL
C 915	4822	122	31316	100PF	2	100	CERAMIC PLATE
C 916	5322	125	54003	60PF	-	300	TRIMMER
C 917	5322	121	54228	392PF	1	630	POLYSTYRENE FOIL
C 918	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 919	4822	122	31177	470PF	10	100	CERAMIC PLATE
C 920	5322	122	34143	10PF	2	100	CERAMIC PLATE
C 921	4822	124	20707	6,8UF	-10+50	40	ELECTROLYTIC
C 922	4822	124	20697	10UF	-10+50	25	ELECTROLYTIC
C 923	4822	124	20689	68UF	-10+50	16	ELECTROLYTIC
C 924	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 925	4822	122	31054	10PF	2	100	CERAMIC PLATE
C 926	4822	121	40438	470NF	10	100	POLYESTER FOIL
C 927	4822	122	30128	4,7HF	10	100	CERAMIC PLATE
C 928	4822	122	31164	1,8NF	10	100	CERAMIC PLATE
C 930	4822	122	31173	220PF	10	100	CERAMIC PLATE
C 931	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 932	4822	122	31189	4,7PF	0,25PF	500	CERAMIC PLATE
C 1100	4822	122	31217	3,9PF	0,25PF	500	CERAMIC PLATE
C 1101	4822	122	31211	100PF	10	500	CERAMIC PLATE
C 1102	4822	121	40407	22NF	10	400	POLYESTER FOIL
C 1103	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1104	4822	122	31177	470PF	10	100	CERAMIC PLATE
C 1106	4822	122	31217	3,9PF	0,25PF	500	CERAMIC PLATE
C 1200	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1201	5322	124	14064	4,7UF	-20+20	25	ELECTROLYTIC TANTALUM
C 1202	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1203	5322	124	14064	4,7UF	-20+20	25	ELECTROLYTIC TANTALUM
C 1204	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1205	4822	122	31081	100PF	2	100	CERAMIC PLATE
C 1206	4822	122	31056	12PF	2	100	CERAMIC PLATE
C 1207	4822	122	31056	12PF	2	100	CERAMIC PLATE
C 1208	4822	122	31081	100PF	2	100	CERAMIC PLATE
C 1209	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1210	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1211	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE

C 1212	4822	122	31081	100PF	2	100	CERAMIC PLATE
C 1213	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1214	4822	122	31081	100PF	2	100	CERAMIC PLATE
C 1216	5322	124	14064	4,7UF	-20+20	25	ELECTROLYTIC TANTALUM
C 1217	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1218	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1219	4822	122	30034	470PF	10	100	CERAMIC PLATE
C 1222	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1223	4822	122	31056	12PF	2	100	CERAMIC PLATE
C 1224	4822	122	31056	12PF	2	100	CERAMIC PLATE
C 1226	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1227	4822	124	20671	68UF	-10+50	6,3	ELECTROLYTIC
C 1228	4822	124	20697	10UF	-10+50	25	ELECTROLYTIC
C 1229	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1231	4822	122	31056	12PF	2	100	CERAMIC PLATE
C 1232	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1233	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1234	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1236	5322	124	14064	4,7UF	-20+20	25	ELECTROLYTIC TANTALUM
C 1301	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1302	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1303	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1304	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1305	4822	122	31063	22PF	2	100	CERAMIC PLATE
C 1306	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1307	5322	121	40224	4,7UF	10	100	POLYESTER FOIL
C 1308	5322	121	54108	47NF	1	63	POLYSTYRENE FOIL
C 1309	5322	121	54062	4,3NF	1	63	POLYSTYRENE FOIL
C 1311	5322	125	54003	60PF	-	300	TRIMMER
C 1312	5322	121	54228	392PF	1	630	POLYSTYRENE FOIL
C 1313	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1314	4822	122	31177	470PF	10	100	CERAMIC PLATE
C 1315	4822	122	31316	100PF	2	100	CERAMIC PLATE
C 1316	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1317	4822	124	20697	10UF	-10+50	25	ELECTROLYTIC
C 1318	4822	124	20707	6,8UF	-10+50	40	ELECTROLYTIC
C 1319	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1320	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1325	4822	122	31222	220PF	2	100	CERAMIC PLATE
C 1501	4822	122	31049	6,8PF	0,25PF	100	CERAMIC PLATE
C 1502	4822	122	30103	22NF	-20+80	40	CERAMIC PLATE
C 1503	4822	122	31168	270PF	2	100	CERAMIC PLATE
C 1505	4822	122	31074	56PF	2	100	CERAMIC PLATE
C 1550	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1551	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1552	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1553	4822	122	31174	2,7NF	10	100	CERAMIC PLATE
C 1554	4822	122	31174	2,7NF	10	100	CERAMIC PLATE
C 1557	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1559	4822	122	31174	2,7NF	10	100	CERAMIC PLATE
C 1561	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1562	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1563	4822	122	31174	2,7NF	10	100	CERAMIC PLATE
C 1564	4822	122	31174	2,7NF	10	100	CERAMIC PLATE
C 1567	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1569	4822	122	31174	2,7NF	10	100	CERAMIC PLATE
C 1601	4822	122	31243	82PF	2	100	CERAMIC PLATE
C 1602	4822	122	31316	100PF	2	100	CERAMIC PLATE
C 1603	4822	122	31063	22PF	2	100	CERAMIC PLATE
C 1604	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1605	4822	122	31074	56PF	2	100	CERAMIC PLATE
C 1606	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1607	4822	122	31316	100PF	2	100	CERAMIC PLATE
C 1608	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1609	4822	124	20589	220UF	-10+50	10	ELECTROLYTIC
C 1611	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1613	4822	122	31177	470PF	10	100	CERAMIC PLATE
C 1614	4822	122	31177	470PF	10	100	CERAMIC PLATE
C 1616	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1617	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE

C 1651	4822	124	20671	68UF	-10+50	6,3	ELECTROLYTIC
C 1652	4822	124	20468	33UF	-10+50	16	ELECTROLYTIC
C 1653	4822	124	20689	68UF	-10+50	16	ELECTROLYTIC
C 1654	4822	124	20671	68UF	-10+50	6,3	ELECTROLYTIC
C 1655	4822	124	20454	150UF	-10+50	6,3	ELECTROLYTIC
C 1656	4822	124	20468	33UF	-10+50	16	ELECTROLYTIC
C 1657	4822	124	20468	33UF	-10+50	16	ELECTROLYTIC
C 1658	4822	124	20671	68UF	-10+50	6,3	ELECTROLYTIC
C 1659	4822	124	20468	33UF	-10+50	16	ELECTROLYTIC
C 1661	4822	124	20689	68UF	-10+50	16	ELECTROLYTIC
C 1662	4822	124	20468	33UF	-10+50	16	ELECTROLYTIC
C 1663	4822	124	20468	33UF	-10+50	16	ELECTROLYTIC
C 1664	4822	124	20671	68UF	-10+50	6,3	ELECTROLYTIC
C 1665	4822	124	20454	150UF	-10+50	6,3	ELECTROLYTIC
C 1701	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 1702	4822	124	20697	10UF	-10+50	25	ELECTROLYTIC
C 1703	5322	122	34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 1704	4822	122	31063	22PF	2	100	CERAMIC PLATE
C 1705	5322	125	50048	3,5PF	—	300	TRIMMER
C 1801	5322	121	44142	220NF	10	250	POLYESTER FOIL
C 1802	5322	124	44007	220UF	-10+50	350	ELECTROLYTIC
C 1803	5322	124	44007	220UF	-10+50	350	ELECTROLYTIC
C 1804	4822	121	40342	47NF	10	630	POLYESTER FOIL
C 1806	5322	122	54024	270PF	10	2000	CERAMIC DISK
C 1807	5322	121	44248	30,1NF	2	500	POLYESTER FOIL
C 1808	5322	121	44248	30,1NF	2	500	POLYESTER FOIL
C 1809	4822	122	30103	22NF	-20+80	40	CERAMIC PLATE
C 1811	4822	122	30103	22NF	-20+80	40	CERAMIC PLATE
C 1812	5322	121	54049	3,3NF	1	63	POLYSTYRENE FOIL
C 1813	4822	122	30103	22NF	-20+80	40	CERAMIC PLATE
C 1814	5322	124	24089	10UF	-20+20	16	ELECTROLYTIC
C 1816	5322	124	24089	10UF	-20+20	16	ELECTROLYTIC
C 1817	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1818	5322	124	24089	10UF	-20+20	16	ELECTROLYTIC
C 1819	5322	124	24099	22UF	-20+20	25	ELECTROLYTIC
C 1821	5322	124	24099	22UF	-20+20	25	ELECTROLYTIC
C 1826	4822	122	31166	560PF	10	500	CERAMIC PLATE
C 1828	5322	124	24212	220UF	-20+20	6,3	ELECTROLYTIC
C 1829	5322	124	24212	220UF	-20+20	6,3	ELECTROLYTIC
C 1831	5322	124	24155	100UF	-20+20	16	ELECTROLYTIC
C 1832	5322	124	24155	100UF	-20+20	16	ELECTROLYTIC
C 1833	4822	121	40456	2,2UF	10	100	POLYESTER FOIL
C 1834	4822	121	40456	2,2UF	10	100	POLYESTER FOIL
C 1836	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1837	4822	121	40411	33NF	10	250	POLYESTER FOIL
C 1838	4822	121	41134	10NF	10	250	POLYESTER FOIL
C 1839	5322	124	24089	10UF	-20+20	16	ELECTROLYTIC
C 1841	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1851	5322	122	54007	220PF	20	5000	CERAMIC DISK
C 1852	5322	122	54007	220PF	20	5000	CERAMIC DISK
C 1853	5322	122	54007	220PF	20	5000	CERAMIC DISK
C 1854	5322	122	54007	220PF	20	5000	CERAMIC DISK
C 1856	5322	122	54007	220PF	20	5000	CERAMIC DISK
C 1857	5322	122	54007	220PF	20	5000	CERAMIC DISK
C 1858	5322	122	54007	220PF	20	5000	CERAMIC DISK
C 1859	5322	122	54007	220PF	20	5000	CERAMIC DISK
C 1861	5322	122	54007	220PF	20	5000	CERAMIC DISK
C 1874	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1876	4822	124	20673	470UF	-10+50	6,3	ELECTROLYTIC
C 1877	4822	124	20698	22UF	-10+50	25	ELECTROLYTIC
C 1878	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1879	4822	122	31168	270PF	2	100	CERAMIC PLATE
C 1881	4822	124	20673	470UF	-10+50	6,3	ELECTROLYTIC
C 1882	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 1901	4822	124	20728	10UF	-10+50	63	ELECTROLYTIC
C 1902	5322	121	40233	680NF	10	100	POLYESTER FOIL
C 1903	4822	121	50611	20NF	1	63	POLYSTYRENE FOIL
C 1904	4822	124	20728	10UF	-10+50	63	ELECTROLYTIC
C 2001	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 2002	4822	122	31052	8,2PF	0,25PF	100	CERAMIC PLATE

C 2003	4822	122	31052	8,2PF	0,25PF	100	CERAMIC PLATE
C 2004	4822	124	20697	10UF	-10+50	25	ELECTROLYTIC
C 2007	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2009	4822	122	31054	10PF	2	100	CERAMIC PLATE
C 2011	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 2012	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 2013	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2014	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 2015	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 2016	4822	122	30128	4,7NF	10	100	CERAMIC PLATE
C 2017	5322	122	50001	4,7NF	-20+50	3K	CERAMIC DISK
C 2018	5322	122	50001	4,7NF	-20+50	3K	CERAMIC DISK
C 2019	5322	122	50001	4,7NF	-20+50	3K	CERAMIC DISK
C 2021	5322	122	50001	4,7NF	-20+50	3K	CERAMIC DISK
C 2022	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2023	4822	122	30103	22NF	-20+80	40	CERAMIC PLATE
C 2026	5322	122	30134	10NF	-20+50	3K	CERAMIC PLATE
C 2027	4822	122	30103	22NF	-20+80	40	CERAMIC PLATE
C 2028	5322	122	54007	220PF	20	5000	CERAMIC DISK
C 2029	5322	122	50001	4,7NF	-20+50	3K	CERAMIC DISK
C 2030	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2031	5322	121	54259	1,2NF	1	125C	POLYSTYRENE FOIL
C 2032	4822	122	30128	4,7NF	10	100	CERAMIC PLATE
C 2033	4822	121	40438	470NF	10	100	POLYESTER FOIL
C 2034	4822	122	31211	100PF	10	500	CERAMIC PLATE
C 2035	5322	122	50001	4,7NF	-20+50	3K	CERAMIC DISK
C 2036	4822	121	40366	15NF	10	1000	POLYESTER FOIL
C 2037	4822	122	31178	680PF	10	500	CERAMIC PLATE
C 2038	5322	122	50044	1NF	-20+50	3K	CERAMIC DISK
C 2039	5322	122	50044	1NF	-20+50	3K	CERAMIC DISK
C 2041	4822	121	41161	100NF	10	250	POLYESTER FOIL
C 2042	4822	124	20697	10UF	-10+50	25	ELECTROLYTIC
C 2043	4822	124	20697	10UF	-10+50	25	ELECTROLYTIC
C 2044	4822	124	20697	10UF	-10+50	25	ELECTROLYTIC
C 2046	4822	121	40522				POLYESTER FOIL
C 2049	4822	122	30128	4,7NF	10	100	CERAMIC PLATE
C 2201	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2202	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2203	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2204	4822	124	20697	10UF	-10+50	25	ELECTROLYTIC
C 2205	4822	124	20698	22UF	-10+50	25	ELECTROLYTIC
C 2301	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2302	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2303	4822	124	20696	3,3UF	-10+100	25	ELECTROLYTIC
C 2304	4822	122	30043	10NF	0	40	CERAMIC PLATE
C 2306	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2307	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2308	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2309	4822	124	20671	68UF	-10+50	6,3	ELECTROLYTIC
C 2311	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2401	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2402	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2403	4822	122	30055	330PF	10	100	CERAMIC PLATE
C 2404	4822	122	30045	27PF	2	100	CERAMIC PLATE
C 2406	4822	122	30055	330PF	10	100	CERAMIC PLATE
C 2407	4822	122	30045	27PF	2	100	CERAMIC PLATE
C 2408	4822	122	31085	150PF	2	100	CERAMIC PLATE
C 2409	4822	122	31067	33PF	2	100	CERAMIC PLATE
C 2411	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2412	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2413	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2414	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2415	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2416	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2417	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2418	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2419	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2420	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2421	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE
C 2422	4822	122	30043	10NF	-20+80	40	CERAMIC PLATE

C 2423	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2424	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2425	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2426	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2431	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2432	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2433	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2434	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2436	4822 124 20697	10UF	-10+50	25	ELECTROLYTIC
C 2438	4822 124 20698	22UF	-10+50	25	ELECTROLYTIC
C 2439	4822 124 20698	22UF	-10+50	25	ELECTROLYTIC
C 2451	4822 122 31072	47PF	2	100	CERAMIC PLATE
C 2452	4822 124 20698	22UF	-10+50	25	ELECTROLYTIC
C 2453	4822 124 20699	47UF	-10+50	25	ELECTROLYTIC
C 2454	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2456	4822 122 31034	1,8PF	0,25PF	100	CERAMIC PLATE
C 2600	4822 122 30094	220PF	10	100	CERAMIC PLATE
C 2601	5322 124 14026	330NF	-20+20	25	ELECTROLYTIC TANTALUM
C 2602	5322 124 14026	330NF	-20+20	25	ELECTROLYTIC TANTALUM
C 2603	5322 124 14026	330NF	-20+20	25	ELECTROLYTIC TANTALUM
C 2604	5322 124 14026	330NF	-20+20	25	ELECTROLYTIC TANTALUM
C 2606	5322 124 14026	330NF	-20+20	25	ELECTROLYTIC TANTALUM
C 2607	5322 124 14026	330NF	-20+20	25	ELECTROLYTIC TANTALUM
C 2608	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 2609	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 2610	4822 124 20454	150UF	-10+50	6,3	ELECTROLYTIC
C 2611	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 2612	4822 124 20689	68UF	-10+50	16	ELECTROLYTIC
C 2613	4822 124 20454	150UF	-10+50	6,3	ELECTROLYTIC
C 2614	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2616	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2617	5322 124 14064	4,7UF	-20+20	25	ELECTROLYTIC TANTALUM
C 2618	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2619	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2620	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2621	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2622	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2623	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2624	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2626	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2627	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2652	4822 124 20678	47UF	-10+50	10	ELECTROLYTIC
C 2653	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2654	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2656	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2657	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2658	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2659	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2661	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2662	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2663	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2664	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2666	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2667	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2668	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2671	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2672	4822 124 20697	10UF	-10+50	25	ELECTROLYTIC

Item	Ordering number			Ohm	Tol (%)	Type	Remarks
Resistors							
R 1	5322	101	44042	100K	20		CARBON POTM LIN + SWITCH
R 2	5322	102	44006	2x47K			CARBON TANDEM POTM + SWITCH
R 3	5322	101	44039	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 4	5322	101	44039	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 5	5322	101	44039	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 6	5322	101	24129	4,7K	20	0.1W	CARBON POTM LIN
R 7	5322	101	44039	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 8	5322	101	44038	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 9	5322	101	44038	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 10	5322	101	44023	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 11	5322	101	44023	10K	20	0.1W	CARBON POTM LIN + SWITCH
R 12	5322	101	24148	10K	20	0.1W	CARBON POTM LIN
R 13	5322	101	24148	10K	20	0.1W	CARBON POTM LIN
R 14	5322	101	44037	100K	20		CARBON POTM LIN + SWITCH
R 15	5322	101	24131	22K	20	0.1W	CARBON POTM LIN
R 16	5322	101	24132	10K	20	0.1W	CARBON POTM LIN
R 17	5322	101	24133	4,7M	20	0.1W	CARBON POTM LIN
R 18	5322	102	34019	2x4K7			CARBON TANDEM POTM
R 100	5322	116	50452	10	1	MR25	METAL FILM
R 101	5322	111	44121	1,8M	5	0.125W	CARBON
R 102	5322	116	64045	10	5	0.125W	METAL OXIDE
R 103	4822	116	51123	1K	5	0.125W	METAL FILM
R 104	5322	116	55152	900K	0,5	SPEC	METAL FILM
R 105	5322	116	64108	22	5	0.125W	METAL OXIDE
R 106	5322	116	55316	111K	0,5	MR25	METAL FILM
R 107	5322	116	64049	47	5	0.125W	METAL OXIDE
R 108	4822	116	51123	1K	5	0.125W	METAL FILM
R 109	5322	116	55153	992K	0,5	SPEC	METAL FILM
R 111	5322	116	55285	10,1K	0,5	MR25	METAL FILM
R 112	5322	116	64049	47	5	0.125W	METAL OXIDE
R 113	5322	116	64051	15	5	0.125W	METAL OXIDE
R 114	5322	111	30376	100M	5	0.125W	CARBON
R 116	5322	116	64051	15	5	0.125W	METAL OXIDE
R 117	5322	116	54442	51,1	1	MR25	METAL FILM
R 118	5322	116	54012	6,81K	1	MR25	METAL FILM
R 119	5322	116	50572	12,1K	1	MR25	METAL FILM
R 121	5322	116	54536	750	1	MR25	METAL FILM
R 122	5322	116	54335	750K	1	MR30	METAL FILM
R 123	5322	116	54735	255K	1	MR25	METAL FILM
R 124	5322	100	10143	1K	20	0.75W	TRIMMING POTM
R 126	4822	116	51272	221K	1	MR25	METAL FILM
R 127	4822	110	42214	10M	5	VR37	CARBON
R 128	4822	110	42227	33M	5	VR37	CARBON
R 129	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 131	5322	116	54595	5,11K	1	MR25	METAL FILM
R 132	5322	101	14056	47K	20	0.75W	TRIMMING POTM
R 133	5322	116	54696	100K	1	MR25	METAL FILM
R 134	5322	116	54743	301K	1	MR25	METAL FILM
R 141	5322	116	54504	274	1	MR25	METAL FILM
R 150	5322	116	50452	10	1	MR25	METAL FILM
R 151	5322	111	44121	1,8M	5	0.125W	CARBON
R 152	5322	116	64045	10	5	0.125W	METAL OXIDE
R 153	4822	116	51123	1K	5	0.125W	METAL FILM
R 154	5322	116	55152	900K	0,5	SPEC	METAL FILM
R 155	5322	116	64108	22	5	0.125W	METAL OXIDE
R 156	5322	116	55316	111K	0,5	MR25	METAL FILM
R 157	5322	116	64049	47	5	0.125W	METAL OXIDE
R 158	4822	116	51123	1K	5	0.125W	METAL FILM
R 159	5322	116	55153	992K	0,5	SPEC	METAL FILM
R 161	5322	116	55285	10,1K	0,5	MR25	METAL FILM
R 162	5322	116	64049	47	5	0.125W	METAL OXIDE
R 163	5322	116	64051	15	5	0.125W	METAL OXIDE
R 164	5322	111	30376	100M	5	0.125W	CARBON
R 166	5322	116	64051	15	5	0.125W	METAL OXIDE
R 167	5322	116	54442	51,1	1	MR25	METAL FILM
R 168	5322	116	54012	6,81K	1	MR25	METAL FILM
R 169	5322	116	50572	12,1K	1	MR25	METAL FILM
R 171	5322	116	54536	750	1	MR25	METAL FILM

K 172	5322	116	54335	750K	1	MR30	METAL FILM
R 173	5322	116	54735	255K	1	MR25	METAL FILM
R 174	5322	100	10143	1K	20	0.75W	TRIMMING POTM
R 176	4822	116	51272	221K	1	MR25	METAL FILM
R 177	4822	110	42214	10M	5	VR37	CARBON
R 178	4822	110	42227	33M	5	VR37	CARBON
R 179	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 181	5322	116	54595	5,11K	1	MR25	METAL FILM
R 182	5322	101	14056	47K	20	0.75W	TRIMMING POTM
R 183	5322	116	54696	100K	1	MR25	METAL FILM
R 184	5322	116	54743	301K	1	MR25	METAL FILM
R 191	5322	116	54504	274	1	MR25	METAL FILM
R 201	5322	116	50621	536	1	MR25	METAL FILM
R 202	5322	116	50904	30,1	1	MR25	METAL FILM
R 203	5322	116	50904	30,1	1	MR25	METAL FILM
R 206	5322	116	54442	51,1	1	MR25	METAL FILM
R 207	5322	116	64071	160	5	0.125W	METAL OXIDE
R 208	5322	116	54469	100	1	MR25	METAL FILM
R 209	5322	116	50583	5,9K	1	MR25	METAL FILM
R 211	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 212	5322	116	54595	5,11K	1	MR25	METAL FILM
R 213	5322	116	64071	160	5	0.125W	METAL OXIDE
R 214	5322	116	54469	100	1	MR25	METAL FILM
R 215	5322	116	54469	100	1	MR25	METAL FILM
R 216	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 217	5322	116	50593	16,2K	1	MR25	METAL FILM
R 218	5322	116	54499	249	1	MR25	METAL FILM
R 219	5322	116	54469	100	1	MR25	METAL FILM
R 221	5322	116	54499	249	1	MR25	METAL FILM
R 222	5322	116	54469	100	1	MR25	METAL FILM
R 223	5322	116	54009	562	1	MR25	METAL FILM
R 224	5322	116	50608	6,19K	1	MR25	METAL FILM
R 225	5322	116	54549	1K	1	MR25	METAL FILM
R 226	5322	116	50593	16,2K	1	MR25	METAL FILM
R 227	5322	116	54511	316	1	MR25	METAL FILM
R 228	5322	116	50636	2,74K	1	MR25	METAL FILM
R 229	5322	116	54585	3,48K	1	MR25	METAL FILM
R 231	5322	116	54597	5,36K	1	MR25	METAL FILM
R 232	5322	116	54469	100	1	MR25	METAL FILM
R 233	5322	116	55601	56,2	0,1	MR24E	METAL FILM
R 234	5322	116	54364	59	0,1	MR24E	METAL FILM
R 235	5322	116	50863	9,09	1	MR25	METAL FILM
R 236	5322	116	54995	237	0,1	MR24E	METAL FILM
R 237	5322	116	55601	56,2	0,1	MR24E	METAL FILM
R 238	5322	116	54364	59	0,1	MR24E	METAL FILM
R 239	5322	116	54995	237	0,1	MR24E	METAL FILM
R 240	5322	116	50863	9,09	1	MR25	METAL FILM
R 241	5322	116	54696	100K	1	MR25	METAL FILM
R 242	5322	116	54696	100K	1	MR25	METAL FILM
R 243	5322	116	54585	3,48K	1	MR25	METAL FILM
R 244	5322	100	10138	100	20	0.75W	TRIMMING POTM
R 247	5322	116	50452	10	1	MR25	METAL FILM
R 248	5322	116	50678	20,5	1	MR25	METAL FILM
R 249	4822	116	51282	511	1	MR25	METAL FILM
R 251	5322	116	50678	20,5	1	MR25	METAL FILM
R 252	5322	116	50452	10	1	MR25	METAL FILM
R 253	5322	100	10144	2,2K	20	0.75W	TRIMMING POTM
R 254	5322	100	10139	4,7K	20	0.75W	TRIMMING POTM
R 256	5322	116	54549	1K	1	MR25	METAL FILM
R 257	5322	100	10139	4,7K	20	0.75W	TRIMMING POTM
R 258	5322	116	50583	5,9K	1	MR25	METAL FILM
R 259	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 261	5322	116	54469	100	1	MR25	METAL FILM
R 262	5322	116	50452	10	1	MR25	METAL FILM
R 263	5322	116	50452	10	1	MR25	METAL FILM
R 264	5322	116	54469	100	1	MR25	METAL FILM
R 266	5322	116	54469	100	1	MR25	METAL FILM
R 267	5322	116	54469	100	1	MR25	METAL FILM
R 268	5322	116	50484	4,64K	1	MR25	METAL FILM
R 269	5322	116	50484	4,64K	1	MR25	METAL FILM

R 271	5322	116	54549	1K	1	MR25	METAL FILM
R 272	5322	116	50593	16,2K	1	MR25	METAL FILM
R 273	5322	116	54484	140	1	MR25	METAL FILM
R 274	5322	116	54469	100	1	MR25	METAL FILM
R 276	5322	116	50621	536	1	MR25	METAL FILM
R 277	5322	116	54561	1,33K	1	MR25	METAL FILM
R 278	4822	116	51233	681	1	MR25	METAL FILM
R 279	5322	116	50452	10	1	MR25	METAL FILM
R 281	5322	116	50452	10	1	MR25	METAL FILM
R 282	5322	116	50452	10	1	MR25	METAL FILM
R 283	5322	116	54469	100	1	MR25	METAL FILM
R 284	5322	116	50484	4,64K	1	MR25	METAL FILM
R 286	5322	116	54595	5,11K	1	MR25	METAL FILM
R 287	5322	116	54595	5,11K	1	MR25	METAL FILM
R 288	5322	116	54469	100	1	MR25	METAL FILM
R 301	5322	116	50621	536	1	MR25	METAL FILM
R 302	5322	116	50904	30,1	1	MR25	METAL FILM
R 303	5322	116	50904	30,1	1	MR25	METAL FILM
R 306	5322	116	54442	51,1	1	MR25	METAL FILM
R 307	5322	116	64071	160	5	0.125W	METAL OXIDE
R 308	5322	116	54469	100	1	MR25	METAL FILM
R 309	5322	116	50583	5,9K	1	MR25	METAL FILM
R 311	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 312	5322	116	54595	5,11K	1	MR25	METAL FILM
R 313	5322	116	64071	160	5	0.125W	METAL OXIDE
R 314	5322	116	54469	100	1	MR25	METAL FILM
R 315	5322	116	54469	100	1	MR25	METAL FILM
R 316	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 317	4822	116	51253	10K	1	MR25	METAL FILM
R 318	5322	116	54499	249	1	MR25	METAL FILM
R 319	5322	116	54469	100	1	MR25	METAL FILM
R 321	5322	116	54499	249	1	MR25	METAL FILM
R 322	5322	116	54469	100	1	MR25	METAL FILM
R 323	5322	116	54009	562	1	MR25	METAL FILM
R 324	5322	116	50608	6,19K	1	MR25	METAL FILM
R 325	5322	116	54549	1K	1	MR25	METAL FILM
R 326	5322	116	50593	16,2K	1	MR25	METAL FILM
R 327	5322	116	54511	316	1	MR25	METAL FILM
R 328	5322	116	50636	2,74K	1	MR25	METAL FILM
R 329	5322	116	54585	3,48K	1	MR25	METAL FILM
R 331	5322	116	54597	5,36K	1	MR25	METAL FILM
R 332	5322	116	54469	100	1	MR25	METAL FILM
R 333	5322	116	55601	56,2	0,1	MR24E	METAL FILM
R 334	5322	116	54364	59	0,1	MR24E	METAL FILM
R 335	5322	116	50863	9,09	1	MR25	METAL FILM
R 336	5322	116	54995	237	0,1	MR24E	METAL FILM
R 337	5322	116	55601	56,2	0,1	MR24E	METAL FILM
R 338	5322	116	54364	59	0,1	MR24E	METAL FILM
R 339	5322	116	54995	237	0,1	MR24E	METAL FILM
R 340	5322	116	50863	9,09	1	MR25	METAL FILM
R 341	5322	116	54696	100K	1	MR25	METAL FILM
R 342	5322	116	54696	100K	1	MR25	METAL FILM
R 343	5322	116	54585	3,48K	1	MR25	METAL FILM
R 344	5322	100	10138	100	20	0.75W	TRIMMING POTM
R 347	5322	116	50452	10	1	MR25	METAL FILM
R 348	5322	116	50678	20,5	1	MR25	METAL FILM
R 349	4822	116	51282	511	1	MR25	METAL FILM
R 351	5322	116	50678	20,5	1	MR25	METAL FILM
R 352	5322	116	50452	10	1	MR25	METAL FILM
R 353	5322	100	10144	2,2K	20	0.75W	TRIMMING POTM
R 354	5322	100	10139	4,7K	20	0.75W	TRIMMING POTM
R 356	5322	116	54549	1K	1	MR25	METAL FILM
R 357	5322	100	10139	4,7K	20	0.75W	TRIMMING POTM
R 358	5322	116	50583	5,9K	1	MR25	METAL FILM
R 359	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 361	5322	116	54469	100	1	MR25	METAL FILM
R 362	5322	116	50452	10	1	MR25	METAL FILM
R 363	5322	116	50452	10	1	MR25	METAL FILM
R 364	5322	116	54469	100	1	MR25	METAL FILM
R 366	5322	116	54469	100	1	MR25	METAL FILM

R 367	5322 116 54469	100	1	MR25	METAL FILM
R 368	5322 116 50484	4,64K	1	MR25	METAL FILM
R 369	5322 116 50484	4,64K	1	MR25	METAL FILM
R 371	5322 116 54549	1K	1	MR25	METAL FILM
R 372	5322 116 50593	16,2K	1	MR25	METAL FILM
R 373	4822 116 51233	681	1	MR25	METAL FILM
R 374	5322 116 54469	100	1	MR25	METAL FILM
R 376	5322 116 50621	536	1	MR25	METAL FILM
R 377	5322 116 54561	1,33K	1	MR25	METAL FILM
R 378	5322 116 54484	140	1	MR25	METAL FILM
R 379	5322 116 50452	10	1	MR25	METAL FILM
R 381	5322 116 50452	10	1	MR25	METAL FILM
R 382	5322 116 50452	10	1	MR25	METAL FILM
R 383	5322 116 54469	100	1	MR25	METAL FILM
R 384	5322 116 50484	4,64K	1	MR25	METAL FILM
R 386	5322 116 54595	5,11K	1	MR25	METAL FILM
R 387	5322 116 54595	5,11K	1	MR25	METAL FILM
R 388	5322 116 54469	100	1	MR25	METAL FILM
R 401	5322 116 54585	3,48K	1	MR25	METAL FILM
R 402	5322 116 54499	249	1	MR25	METAL FILM
R 403	5322 116 54585	3,48K	1	MR25	METAL FILM
R 404	5322 116 54469	100	1	MR25	METAL FILM
R 406	5322 116 50904	30,1	1	MR25	METAL FILM
R 407	5322 116 50904	30,1	1	MR25	METAL FILM
R 408	5322 116 50586	1,54K	1	MR25	METAL FILM
R 409	5322 100 10139	4,7K	20	0.75W	TRIMMING POTM
R 411	5322 100 10144	2,2K	20	0.75W	TRIMMING POTM
R 412	5322 116 50904	30,1	1	MR25	METAL FILM
R 413	5322 100 10133	220	20	0.75W	TRIMMING POTM
R 416	5322 100 10138	100	20	0.75W	TRIMMING POTM
R 418	5322 116 54516	365	1	MR25	METAL FILM
R 419	5322 116 54492	178	1	MR25	METAL FILM
R 421	5322 116 50452	10	1	MR25	METAL FILM
R 422	5322 116 50452	10	1	MR25	METAL FILM
R 424	5322 116 54516	365	1	MR25	METAL FILM
R 426	5322 116 54696	100K	1	MR25	METAL FILM
R 427	5322 116 50583	5,9K	1	MR25	METAL FILM
R 428	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 429	5322 116 50583	5,9K	1	MR25	METAL FILM
R 431	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 432	5322 116 54696	100K	1	MR25	METAL FILM
R 433	5322 116 54469	100	1	MR25	METAL FILM
R 434	5322 116 50766	147	1	MR25	METAL FILM
R 436	5322 116 54558	8,25K	1	MR25	METAL FILM
R 437	5322 116 50671	2,61K	1	MR25	METAL FILM
R 438	5322 116 50664	2,05K	1	MR25	METAL FILM
R 439	5322 116 50572	12,1K	1	MR25	METAL FILM
R 441	4822 116 51253	10K	1	MR25	METAL FILM
R 442	5322 116 50671	2,61K	1	MR25	METAL FILM
R 443	5322 116 50479	15,4K	1	MR25	METAL FILM
R 451	5322 116 54585	3,48K	1	MR25	METAL FILM
R 452	5322 116 54499	249	1	MR25	METAL FILM
R 453	5322 116 54585	3,48K	1	MR25	METAL FILM
R 454	5322 116 54469	100	1	MR25	METAL FILM
R 456	5322 116 50904	30,1	1	MR25	METAL FILM
R 457	5322 116 50904	30,1	1	MR25	METAL FILM
R 458	5322 116 50586	1,54K	1	MR25	METAL FILM
R 459	5322 100 10139	4,7K	20	0.75W	TRIMMING POTM
R 461	5322 100 10144	2,2K	20	0.75W	TRIMMING POTM
R 462	5322 116 50904	30,1	1	MR25	METAL FILM
R 463	5322 100 10133	220	20	0.75W	TRIMMING POTM
R 466	5322 100 10138	100	20	0.75W	TRIMMING POTM
R 468	5322 116 54516	365	1	MR25	METAL FILM
R 469	5322 116 54492	178	1	MR25	METAL FILM
R 471	5322 116 50452	10	1	MR25	METAL FILM
R 472	5322 116 50452	10	1	MR25	METAL FILM
R 474	5322 116 54516	365	1	MR25	METAL FILM
R 476	5322 116 54696	100K	1	MR25	METAL FILM
R 477	5322 116 50583	5,9K	1	MR25	METAL FILM
R 478	5322 100 10141	10K	20	0.75W	TRIMMING POTM

R 479	5322	116	50583	5,9K	1	MR25	METAL FILM
R 481	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 482	5322	116	54696	100K	1	MR25	METAL FILM
R 483	5322	116	54669	100	1	MR25	METAL FILM
R 484	5322	116	50766	147	1	MR25	METAL FILM
R 486	5322	116	54558	8,25K	1	MR25	METAL FILM
R 487	5322	116	50671	2,61K	1	MR25	METAL FILM
R 488	5322	116	50479	15,4K	1	MR25	METAL FILM
R 489	4822	116	51253	10K	1	MR25	METAL FILM
R 491	5322	116	54469	100	1	MR25	METAL FILM
R 493	5322	116	50671	2,61K	1	MR25	METAL FILM
R 494	5322	116	54469	100	1	MR25	METAL FILM
R 500	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 501	5322	116	54484	140	1	MR25	METAL FILM
R 502	5322	116	50766	147	1	MR25	METAL FILM
R 503	5322	116	50511	48,7	1	MR25	METAL FILM
R 504	5322	116	54504	274	1	MR25	METAL FILM
R 505	5322	116	50586	1,54K	1	MR25	METAL FILM
R 506	5322	116	54499	249	1	MR25	METAL FILM
R 507	5322	116	54484	140	1	MR25	METAL FILM
R 508	5322	116	54484	140	1	MR25	METAL FILM
R 509	5322	116	54519	402	1	MR25	METAL FILM
R 510	5322	116	50452	10	1	MR25	METAL FILM
R 511	5322	116	54442	51,1	1	MR25	METAL FILM
R 512	5322	116	50511	48,7	1	MR25	METAL FILM
R 513	5322	116	54504	274	1	MR25	METAL FILM
R 514	5322	116	54499	249	1	MR25	METAL FILM
R 515	5322	116	50452	10	1	MR25	METAL FILM
R 516	5322	116	54448	59	1	MR25	METAL FILM
R 517	5322	116	50524	3,01K	1	MR25	METAL FILM
R 518	5322	116	50636	2,74K	1	MR25	METAL FILM
R 519	5322	100	10138	100	20	0.75W	TRIMMING POTM
R 521	5322	116	50621	536	1	MR25	METAL FILM
R 522	5322	116	54504	274	1	MR25	METAL FILM
R 523	5322	116	50621	536	1	MR25	METAL FILM
R 524	5322	116	54448	59	1	MR25	METAL FILM
R 526	5322	116	50583	5,9K	1	MR25	METAL FILM
R 527	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 528	5322	116	54469	100	1	MR25	METAL FILM
R 529	5322	116	50621	536	1	MR25	METAL FILM
R 531	5322	116	50452	10	1	MR25	METAL FILM
R 534	5322	116	50904	30,1	1	MR25	METAL FILM
R 536	4822	116	51233	631	1	MR25	METAL FILM
R 537	5322	116	50904	30,1	1	MR25	METAL FILM
R 538	5322	116	50452	10	1	MR25	METAL FILM
R 539	5322	116	54549	1K	1	MR25	METAL FILM
R 541	5322	116	50452	10	1	MR25	METAL FILM
R 542	5322	116	50452	10	1	MR25	METAL FILM
R 543	5322	116	54469	100	1	MR25	METAL FILM
R 544	5322	116	50621	536	1	MR25	METAL FILM
R 546	5322	116	50484	4,64K	1	MR25	METAL FILM
R 547	5322	116	54469	100	1	MR25	METAL FILM
R 548	5322	116	50452	10	1	MR25	METAL FILM
R 552	5322	116	54426	121	1	MR25	METAL FILM
R 601	5322	116	50571	715	1	MR25	METAL FILM
R 602	5322	116	54442	51,1	1	MR25	METAL FILM
R 603	5322	116	50669	205	1	MR25	METAL FILM
R 604	5322	116	54448	59	1	MR25	METAL FILM
R 605	5322	116	54448	59	1	MR25	METAL FILM
R 606	5322	116	50729	4,22K	1	MR25	METAL FILM
R 607	5322	116	54469	100	1	MR25	METAL FILM
R 608	5322	116	50675	2,26K	1	MR25	METAL FILM
R 609	5322	116	54442	51,1	1	MR25	METAL FILM
R 610	5322	116	54776	84,5	0,5	MR30	METAL FILM
R 611	5322	116	50571	715	1	MR25	METAL FILM
R 612	5322	116	50669	205	1	MR25	METAL FILM
R 613	5322	116	54448	59	1	MR25	METAL FILM
R 614	5322	116	54012	6,31K	1	MR25	METAL FILM
R 615	5322	116	54448	59	1	MR25	METAL FILM
R 616	5322	116	50484	4,64K	1	MR25	METAL FILM

R 617	5322 116 54515	348	1	MR25	METAL FILM
R 618	5322 116 54484	140	1	MR25	METAL FILM
R 619	5322 116 54558	8,25K	1	MR25	METAL FILM
R 621	5322 116 54469	100	1	MR25	METAL FILM
R 622	5322 116 54562	1,4K	1	MR25	METAL FILM
R 623	5322 116 54462	82,5	1	MR25	METAL FILM
R 624	5322 116 54484	140	1	MR25	METAL FILM
R 626	5322 116 54515	348	1	MR25	METAL FILM
R 627	5322 116 50484	4,64K	1	MR25	METAL FILM
R 628	5322 116 54012	6,81K	1	MR25	METAL FILM
R 629	5322 116 54549	1K	1	MR25	METAL FILM
R 631	5322 116 54511	316	1	MR25	METAL FILM
R 632	5322 116 50636	2,74K	1	MR25	METAL FILM
R 634	5322 101 14066	10K	20	0,5W	TRIMMING POTM
R 636	5322 101 14292	4,7K	20	0,5W	TRIMMING POTM
R 637	5322 116 54469	100	1	MR25	METAL FILM
R 638	5322 116 54469	100	1	MR25	METAL FILM
R 639	5322 116 50452	10	1	MR25	METAL FILM
R 640	4822 116 51253	10K	1	MR25	METAL FILM
R 641	5322 116 50452	10	1	MR25	METAL FILM
R 642	4822 116 51253	10K	1	MR25	METAL FILM
R 643	5322 116 50678	20,5	1	MR25	METAL FILM
R 644	5322 116 50678	20,5	1	MR25	METAL FILM
R 646	5322 101 14066	10K	20	0,5W	TRIMMING POTM
R 647	5322 116 50636	2,74K	1	MR25	METAL FILM
R 649	4822 116 30018	1,3K	10	1W	NTC
R 653	5322 116 50572	12,1K	1	MR25	METAL FILM
R 654	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 655	5322 116 50664	2,05K	1	MR25	METAL FILM
R 656	5322 116 50664	2,05K	1	MR25	METAL FILM
R 657	5322 116 54469	100	1	MR25	METAL FILM
R 658	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 659	5322 116 50766	147	1	MR25	METAL FILM
R 660	5322 116 50766	147	1	MR25	METAL FILM
R 661	5322 116 54469	100	1	MR25	METAL FILM
R 701	5322 116 54442	51,1	1	MR25	METAL FILM
R 702	5322 116 54408	909K	1	MR30	METAL FILM
R 703	5322 116 54701	110K	1	MR25	METAL FILM
R 704	5322 116 54009	562	1	MR25	METAL FILM
R 706	5322 116 54335	750K	1	MR30	METAL FILM
R 707	5322 116 54549	1K	1	MR25	METAL FILM
R 708	5322 116 54549	1K	1	MR25	METAL FILM
R 709	5322 116 54386	249K	1	MR25	METAL FILM
R 711	4822 110 63214	10M	10	CR25	CARBON
R 712	5322 116 50527	33,2	1	MR25	METAL FILM
R 713	5322 116 54012	6,81K	1	MR25	METAL FILM
R 714	5322 116 54648	24,9K	1	MR25	METAL FILM
R 716	5322 116 50572	12,1K	1	MR25	METAL FILM
R 717	5322 116 54696	100K	1	MR25	METAL FILM
R 718	5322 116 54648	24,9K	1	MR25	METAL FILM
R 719	5322 116 54012	6,81K	1	MR25	METAL FILM
R 721	5322 116 50572	12,1K	1	MR25	METAL FILM
R 722	5322 116 54648	24,9K	1	MR25	METAL FILM
R 723	5322 116 54012	6,81K	1	MR25	METAL FILM
R 724	5322 116 54541	825	1	MR25	METAL FILM
R 726	5322 116 54469	100	1	MR25	METAL FILM
R 727	5322 116 54554	1,1K	1	MR25	METAL FILM
R 728	5322 116 54595	5,11K	1	MR25	METAL FILM
R 729	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 730	5322 116 54469	100	1	MR25	METAL FILM
R 731	5322 116 54723	187K	1	MR25	METAL FILM
R 732	5322 116 54605	6,98K	1	MR25	METAL FILM
R 733	5322 116 50581	2,49K	1	MR25	METAL FILM
R 734	5322 116 54685	71,5K	1	MR25	METAL FILM
R 735	5322 116 54595	5,11K	1	MR25	METAL FILM
R 736	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 738	5322 116 50669	205	1	MR25	METAL FILM
R 741	5322 116 54529	619	1	MR25	METAL FILM
R 742	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 800	5322 116 50664	2,05K	1	MR25	METAL FILM

R 801	5322	116	54469	100	1	MR25	METAL FILM
R 802	5322	116	54536	750	1	MR25	METAL FILM
R 803	5322	116	50556	4,42K	1	MR25	METAL FILM
R 804	5322	116	54541	825	1	MR25	METAL FILM
R 805	5322	116	54469	100	1	MR25	METAL FILM
R 806	4822	116	51282	511	1	MR25	METAL FILM
R 807	5322	116	54536	750	1	MR25	METAL FILM
R 808	5322	116	54469	100	1	MR25	METAL FILM
R 809	5322	116	50492	46,4	1	MR25	METAL FILM
R 810	5322	116	54469	100	1	MR25	METAL FILM
R 811	5322	116	50491	22,6	1	MR25	METAL FILM
R 812	5322	116	54585	3,48K	1	MR25	METAL FILM
R 813	5322	116	54558	8,25K	1	MR25	METAL FILM
R 814	5322	116	50491	22,6	1	MR25	METAL FILM
R 815	5322	116	50492	46,4	1	MR25	METAL FILM
R 816	5322	116	54511	316	1	MR25	METAL FILM
R 817	5322	116	54442	51,1	1	MR25	METAL FILM
R 818	5322	116	54442	51,1	1	MR25	METAL FILM
R 819	5322	116	50635	1,47K	1	MR25	METAL FILM
R 821	5322	116	50635	1,47K	1	MR25	METAL FILM
R 822	5322	116	50558	18,7K	1	MR25	METAL FILM
R 823	5322	116	50558	18,7K	1	MR25	METAL FILM
R 824	5322	116	54469	100	1	MR25	METAL FILM
R 826	5322	116	50635	1,47K	1	MR25	METAL FILM
R 827	5322	116	50635	1,47K	1	MR25	METAL FILM
R 828	5322	116	50558	18,7K	1	MR25	METAL FILM
R 829	5322	116	50558	18,7K	1	MR25	METAL FILM
R 831	5322	116	54469	100	1	MR25	METAL FILM
R 832	5322	116	50635	1,47K	1	MR25	METAL FILM
R 833	5322	116	50635	1,47K	1	MR25	METAL FILM
R 834	5322	116	50558	18,7K	1	MR25	METAL FILM
R 835	5322	100	10143	1K	20	0.75W	TRIMMING POTM
R 836	5322	116	50558	18,7K	1	MR25	METAL FILM
R 837	5322	116	54442	51,1	1	MR25	METAL FILM
R 838	5322	116	54442	51,1	1	MR25	METAL FILM
R 839	5322	116	54541	825	1	MR25	METAL FILM
R 841	5322	116	50669	205	1	MR25	METAL FILM
R 842	5322	100	10143	1K	20	0.75W	TRIMMING POTM
R 843	5322	100	10143	1K	20	0.75W	TRIMMING POTM
R 844	5322	116	50527	33,2	1	MR25	METAL FILM
R 846	5322	116	54516	365	1	MR25	METAL FILM
R 847	5322	116	54516	365	1	MR25	METAL FILM
R 848	5322	116	55278	909	1	MR25	METAL FILM
R 849	5322	116	50766	147	1	MR25	METAL FILM
R 851	5322	116	55278	909	1	MR25	METAL FILM
R 852	5322	116	50491	22,6	1	MR25	METAL FILM
R 853	5322	116	54469	100	1	MR25	METAL FILM
R 854	5322	116	50569	95,3	1	MR25	METAL FILM
R 856	5322	116	54536	750	1	MR25	METAL FILM
R 857	5322	116	50569	95,3	1	MR25	METAL FILM
R 858	5322	116	50527	33,2	1	MR25	METAL FILM
R 859	5322	116	54541	825	1	MR25	METAL FILM
R 860	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 861	5322	116	50527	33,2	1	MR25	METAL FILM
R 863	5322	116	54502	261	1	MR25	METAL FILM
R 864	5322	116	54426	121	1	MR25	METAL FILM
R 865	5322	116	50452	10	1	MR25	METAL FILM
R 866	5322	116	54426	121	1	MR25	METAL FILM
R 867	5322	116	50527	33,2	1	MR25	METAL FILM
R 868	5322	116	54511	316	1	MR25	METAL FILM
R 869	5322	116	54513	332	1	MR25	METAL FILM
R 871	5322	116	54466	90,9	1	MR25	METAL FILM
R 872	5322	116	50491	22,6	1	MR25	METAL FILM
R 873	5322	116	50593	16,2K	1	MR25	METAL FILM
R 874	5322	116	54442	51,1	1	MR25	METAL FILM
R 875	5322	116	50491	22,6	1	MR25	METAL FILM
R 876	5322	116	54442	51,1	1	MR25	METAL FILM
R 877	5322	116	54543	866	1	MR25	METAL FILM
R 878	4822	116	51233	681	1	MR25	METAL FILM
R 879	5322	116	50586	1,54K	1	MR25	METAL FILM

R 881	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 882	5322	116	54469	100	1	MR25	METAL FILM
R 883	5322	116	54511	316	1	MR25	METAL FILM
R 884	5322	116	54513	332	1	MR25	METAL FILM
R 886	5322	116	54466	90,9	1	MR25	METAL FILM
R 887	5322	116	50491	22,6	1	MR25	METAL FILM
R 888	5322	116	50593	16,2K	1	MR25	METAL FILM
R 889	5322	116	54442	51,1	1	MR25	METAL FILM
R 891	5322	116	50491	22,6	1	MR25	METAL FILM
R 892	5322	116	54442	51,1	1	MR25	METAL FILM
R 893	5322	116	54511	316	1	MR25	METAL FILM
R 894	5322	116	54469	100	1	MR25	METAL FILM
R 896	5322	116	54192	5,11	1	MR25	METAL FILM
R 897	5322	116	54511	316	1	MR25	METAL FILM
R 898	5322	116	54549	1K	1	MR25	METAL FILM
R 899	4822	116	51253	10K	1	MR25	METAL FILM
R 900	5322	116	54567	1,69K	1	MR25	METAL FILM
R 901	5322	116	50664	2,05K	1	MR25	METAL FILM
R 902	5322	116	54549	1K	1	MR25	METAL FILM
R 903	5322	116	54541	825	1	MR25	METAL FILM
R 904	5322	116	50527	33,2	1	MR25	METAL FILM
R 905	5322	116	54508	301	1	MR25	METAL FILM
R 906	5322	116	50536	464	1	MR25	METAL FILM
R 907	5322	116	50536	464	1	MR25	METAL FILM
R 908	5322	116	50675	2,26K	1	MR25	METAL FILM
R 909	5322	116	50675	2,26K	1	MR25	METAL FILM
R 910	5322	116	54606	7,15K	1	MR25	METAL FILM
R 911	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 912	5322	116	54595	5,11K	1	MR25	METAL FILM
R 913	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 914	5322	116	54536	750	1	MR25	METAL FILM
R 916	5322	116	50581	2,49K	1	MR25	METAL FILM
R 917	4822	116	51253	10K	1	MR25	METAL FILM
R 918	5322	116	54589	3,33K	1	MR25	METAL FILM
R 919	5322	116	50527	33,2	1	MR25	METAL FILM
R 920	5322	116	54508	301	1	MR25	METAL FILM
R 921	5322	116	50572	12,1K	1	MR25	METAL FILM
R 922	5322	116	50583	5,9K	1	MR25	METAL FILM
R 923	5322	116	50527	33,2	1	MR25	METAL FILM
R 924	5322	116	50527	33,2	1	MR25	METAL FILM
R 926	5322	116	54249	487	0,25	MR24C	METAL FILM
R 927	5322	116	50481	22,6K	1	MR25	METAL FILM
R 928	5322	116	54549	1K	1	MR25	METAL FILM
R 929	5322	116	50481	22,6K	1	MR25	METAL FILM
R 931	5322	116	50536	464	1	MR25	METAL FILM
R 932	5322	116	50481	22,6K	1	MR25	METAL FILM
R 933	5322	116	54549	1K	1	MR25	METAL FILM
R 934	5322	116	50954	38,3	1	MR25	METAL FILM
R 936	4822	116	51253	10K	1	MR25	METAL FILM
R 937	4822	116	51253	10K	1	MR25	METAL FILM
R 938	4822	110	63207	5,6M	10	CR25	CARBON
R 939	4822	116	51253	10K	1	MR25	METAL FILM
R 940	5322	116	54513	332	1	MR25	METAL FILM
R 941	5322	116	54192	5,11	1	MR25	METAL FILM
R 942	5322	116	50664	2,05K	1	MR25	METAL FILM
R 943	5322	116	54455	68,1	1	MR25	METAL FILM
R 944	5322	116	50482	33,2K	1	MR25	METAL FILM
R 945	5322	116	50527	33,2	1	MR25	METAL FILM
R 946	5322	116	50581	2,49K	1	MR25	METAL FILM
R 947	5322	116	50664	2,05K	1	MR25	METAL FILM
R 948	5322	116	50728	1,87K	1	MR25	METAL FILM
R 949	5322	116	54466	90,9	1	MR25	METAL FILM
R 950	4822	116	51282	511	1	MR25	METAL FILM
R 951	5322	116	54513	332	1	MR25	METAL FILM
R 952	5322	116	54504	274	1	MR25	METAL FILM
R 953	5322	116	54469	100	1	MR25	METAL FILM
R 954	5322	116	54504	274	1	MR25	METAL FILM
R 955	5322	116	54595	5,11K	1	MR25	METAL FILM
R 956	5322	116	54536	750	1	MR25	METAL FILM
R 957	5322	116	50491	22,6	1	MR25	METAL FILM

R 958	5322	116	54536	750	1	MR25	METAL FILM
R 959	5322	116	54005	3,32K	1	MR25	METAL FILM
R 960	5322	116	54012	6,81K	1	MR25	METAL FILM
R 961	5322	116	54549	1K	1	MR25	METAL FILM
R 962	5322	116	54549	1K	1	MR25	METAL FILM
R 963	5322	116	50669	205	1	MR25	METAL FILM
R 964	5322	116	50481	22,6K	1	MR25	METAL FILM
R 965	5322	116	50482	33,2K	1	MR25	METAL FILM
R 966	5322	116	54009	562	1	MR25	METAL FILM
R 967	5322	116	54504	274	1	MR25	METAL FILM
R 968	5322	116	54504	274	1	MR25	METAL FILM
R 969	5322	116	54469	100	1	MR25	METAL FILM
R 970	4822	116	51253	10K	1	MR25	METAL FILM
R 971	5322	116	50635	1,47K	1	MR25	METAL FILM
R 972	4822	116	51253	10K	1	MR25	METAL FILM
R 973	5322	116	50536	464	1	MR25	METAL FILM
R 974	5322	116	50593	16,2K	1	MR25	METAL FILM
R 975	5322	116	54469	100	1	MR25	METAL FILM
R 976	5322	116	50482	33,2K	1	MR25	METAL FILM
R 977	5322	116	50479	15,4K	1	MR25	METAL FILM
R 978	5322	116	50635	1,47K	1	MR25	METAL FILM
R 980	4822	116	51253	10K	1	MR25	METAL FILM
R 981	5322	116	54549	1K	1	MR25	METAL FILM
R 982	5322	116	54549	1K	1	MR25	METAL FILM
R 983	5322	116	50481	22,6K	1	MR25	METAL FILM
R 984	5322	116	54519	402	1	MR25	METAL FILM
R 985	5322	116	55315	619K	1	MR25	METAL FILM
R 986	5322	116	50527	33,2	1	MR25	METAL FILM
R 987	5322	116	50482	33,2K	1	MR25	METAL FILM
R 992	5322	116	50555	1,27K	1	MR25	METAL FILM
R 993	5322	116	54549	1K	1	MR25	METAL FILM
R 994	5322	116	50767	2,15K	1	MR25	METAL FILM
R 995	5322	116	54508	301	1	MR25	METAL FILM
R 996	5322	116	54508	301	1	MR25	METAL FILM
R 997	5322	116	54442	51,1	1	MR25	METAL FILM
R 998	4822	116	51253	10K	1	MR25	METAL FILM
R 1001	5322	116	54877	402	0,25	MR24C	METAL FILM
R 1002	5322	116	54902	876K	0,25	MR54C	METAL FILM
R 1003	5322	116	54901	887K	0,25	MR54C	METAL FILM
R 1004	5322	116	54896	354K	0,25	MR34C	METAL FILM
R 1006	5322	116	54899	176K	0,25	MR34C	METAL FILM
R 1007	5322	116	54897	87,6K	0,25	MR24C	METAL FILM
R 1008	5322	116	54895	34,6K	0,25	MR24C	METAL FILM
R 1009	5322	116	54894	16,8K	0,25	MR24C	METAL FILM
R 1011	5322	116	55161	7,96K	0,25	MR24C	METAL FILM
R 1012	5322	116	50784	2,67K	0,25	MR24C	METAL FILM
R 1013	5322	116	54898	887	0,25	MR24C	METAL FILM
R 1014	5322	116	54504	274	1	MR25	METAL FILM
R 1101	5322	116	54469	100	1	MR25	METAL FILM
R 1102	5322	116	54335	750K	1	MR30	METAL FILM
R 1103	5322	116	54549	1K	1	MR25	METAL FILM
R 1104	5322	116	54549	1K	1	MR25	METAL FILM
R 1106	5322	116	54386	249K	1	MR25	METAL FILM
R 1107	4822	110	63214	10M	10	CR25	CARBON
R 1108	5322	116	50581	2,49K	1	MR25	METAL FILM
R 1109	5322	116	50527	33,2	1	MR25	METAL FILM
R 1110	5322	116	50669	205	1	MR25	METAL FILM
R 1111	5322	116	54012	6,81K	1	MR25	METAL FILM
R 1112	5322	116	54648	24,9K	1	MR25	METAL FILM
R 1113	5322	116	54552	1,05K	1	MR25	METAL FILM
R 1114	5322	116	54723	187K	1	MR25	METAL FILM
R 1116	5322	116	54558	8,25K	1	MR25	METAL FILM
R 1117	5322	116	54685	71,5K	1	MR25	METAL FILM
R 1118	5322	100	10113	10K	20	0,5W	TRIMMING POTM
R 1119	5322	116	54595	5,11K	1	MR25	METAL FILM
R 1121	5322	100	10141	10K	20	0,75W	TRIMMING POTM
R 1201	5322	116	50664	2,05K	1	MR25	METAL FILM
R 1202	5322	116	54536	750	1	MR25	METAL FILM
R 1204	5322	116	54469	100	1	MR25	METAL FILM
R 1206	4822	116	51282	511	1	MR25	METAL FILM

R 1207	5322 116 54536	750	1	MR25	METAL FILM
R 1208	5322 116 54469	100	1	MR25	METAL FILM
R 1209	5322 116 50492	46,4	1	MR25	METAL FILM
R 1211	5322 116 54469	100	1	MR25	METAL FILM
R 1212	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1213	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1214	5322 116 50491	22,6	1	MR25	METAL FILM
R 1215	5322 116 50492	46,4	1	MR25	METAL FILM
R 1216	5322 116 54511	316	1	MR25	METAL FILM
R 1217	5322 116 54442	51,1	1	MR25	METAL FILM
R 1218	5322 116 54442	51,1	1	MR25	METAL FILM
R 1219	5322 116 50635	1,47K	1	MR25	METAL FILM
R 1221	5322 116 50635	1,47K	1	MR25	METAL FILM
R 1222	5322 116 50558	18,7K	1	MR25	METAL FILM
R 1223	5322 116 50558	18,7K	1	MR25	METAL FILM
R 1224	5322 116 54469	100	1	MR25	METAL FILM
R 1226	5322 116 50635	1,47K	1	MR25	METAL FILM
R 1227	5322 116 50635	1,47K	1	MR25	METAL FILM
R 1228	5322 116 50558	18,7K	1	MR25	METAL FILM
R 1229	5322 116 50558	18,7K	1	MR25	METAL FILM
R 1231	5322 116 54469	100	1	MR25	METAL FILM
R 1232	5322 116 50635	1,47K	1	MR25	METAL FILM
R 1233	5322 116 50635	1,47K	1	MR25	METAL FILM
R 1234	5322 116 50558	18,7K	1	MR25	METAL FILM
R 1235	5322 100 10143	1K	20	0.75W	TRIMMING POTM
R 1236	5322 116 50558	18,7K	1	MR25	METAL FILM
R 1237	5322 116 50491	22,6	1	MR25	METAL FILM
R 1238	5322 116 54469	100	1	MR25	METAL FILM
R 1239	5322 116 54448	59	1	MR25	METAL FILM
R 1241	5322 116 54536	750	1	MR25	METAL FILM
R 1242	5322 116 50527	33,2	1	MR25	METAL FILM
R 1243	5322 116 54541	825	1	MR25	METAL FILM
R 1244	5322 116 50527	33,2	1	MR25	METAL FILM
R 1247	5322 116 54426	121	1	MR25	METAL FILM
R 1248	5322 116 54426	121	1	MR25	METAL FILM
R 1249	5322 116 50527	33,2	1	MR25	METAL FILM
R 1251	5322 116 54502	261	1	MR25	METAL FILM
R 1252	5322 116 54442	51,1	1	MR25	METAL FILM
R 1253	5322 116 54442	51,1	1	MR25	METAL FILM
R 1254	5322 116 50491	22,6	1	MR25	METAL FILM
R 1255	5322 116 50491	22,6	1	MR25	METAL FILM
R 1256	5322 116 54442	51,1	1	MR25	METAL FILM
R 1257	5322 116 54442	51,1	1	MR25	METAL FILM
R 1258	5322 116 54511	316	1	MR25	METAL FILM
R 1259	5322 116 54513	332	1	MR25	METAL FILM
R 1260	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 1261	5322 116 54466	90,9	1	MR25	METAL FILM
R 1262	5322 116 50593	16,2K	1	MR25	METAL FILM
R 1263	5322 116 50491	22,6	1	MR25	METAL FILM
R 1264	5322 116 54543	866	1	MR25	METAL FILM
R 1266	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1267	4822 116 51233	681	1	MR25	METAL FILM
R 1268	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 1269	5322 116 54469	100	1	MR25	METAL FILM
R 1270	5322 116 54511	316	1	MR25	METAL FILM
R 1271	5322 116 54513	332	1	MR25	METAL FILM
R 1272	5322 116 54466	90,9	1	MR25	METAL FILM
R 1273	5322 116 50491	22,6	1	MR25	METAL FILM
R 1274	5322 116 50593	16,2K	1	MR25	METAL FILM
R 1275	5322 116 54469	100	1	MR25	METAL FILM
R 1276	5322 116 54511	316	1	MR25	METAL FILM
R 1277	5322 116 50679	237	1	MR25	METAL FILM
R 1278	5322 116 54508	301	1	MR25	METAL FILM
R 1279	5322 116 54442	51,1	1	MR25	METAL FILM
R 1281	5322 116 54484	140	1	MR25	METAL FILM
R 1282	5322 116 54504	274	1	MR25	METAL FILM
R 1283	5322 116 54589	3,83K	1	MR25	METAL FILM
R 1284	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1286	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1287	5322 116 54504	274	1	MR25	METAL FILM

R 1288	5322	116	54511	316	1	MR25	METAL FILM
R 1289	5322	116	54549	1K	1	MR25	METAL FILM
R 1290	5322	116	50675	2,26K	1	MR25	METAL FILM
R 1291	5322	116	50664	2,05K	1	MR25	METAL FILM
R 1292	5322	116	54469	100	1	MR25	METAL FILM
R 1293	4822	116	51253	10K	1	MR25	METAL FILM
R 1294	5322	116	50664	2,05K	1	MR25	METAL FILM
R 1295	5322	116	54504	274	1	MR25	METAL FILM
R 1296	5322	116	50664	2,05K	1	MR25	METAL FILM
R 1297	5322	116	54504	274	1	MR25	METAL FILM
R 1298	5322	116	54549	1K	1	MR25	METAL FILM
R 1299	4822	116	51253	10K	1	MR25	METAL FILM
R 1300	5322	116	54562	1,4K	1	MR25	METAL FILM
R 1301	5322	116	50675	2,26K	1	MR25	METAL FILM
R 1303	5322	116	54536	750	1	MR25	METAL FILM
R 1304	5322	116	50509	4,87K	1	MR25	METAL FILM
R 1305	5322	116	50524	3,01K	1	MR25	METAL FILM
R 1306	5322	116	54504	274	1	MR25	METAL FILM
R 1307	5322	116	54504	274	1	MR25	METAL FILM
R 1308	5322	116	50664	2,05K	1	MR25	METAL FILM
R 1309	5322	116	50536	464	1	MR25	METAL FILM
R 1310	4822	116	51253	10K	1	MR25	METAL FILM
R 1311	5322	116	54469	100	1	MR25	METAL FILM
R 1312	5322	116	50536	464	1	MR25	METAL FILM
R 1313	5322	116	54549	1K	1	MR25	METAL FILM
R 1314	5322	116	50527	33,2	1	MR25	METAL FILM
R 1315	4822	116	51253	10K	1	MR25	METAL FILM
R 1316	5322	116	50556	4,42K	1	MR25	METAL FILM
R 1317	5322	116	50675	2,26K	1	MR25	METAL FILM
R 1318	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 1319	5322	116	50675	2,26K	1	MR25	METAL FILM
R 1320	4822	116	51253	10K	1	MR25	METAL FILM
R 1321	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 1322	5322	116	54595	5,11K	1	MR25	METAL FILM
R 1323	5322	116	54536	750	1	MR25	METAL FILM
R 1324	5322	116	54595	5,11K	1	MR25	METAL FILM
R 1325	5322	116	54696	100K	1	MR25	METAL FILM
R 1326	5322	100	10141	10K	20	0.75W	TRIMMING POTM
R 1327	5322	116	54589	3,83K	1	MR25	METAL FILM
R 1328	4822	116	51253	10K	1	MR25	METAL FILM
R 1329	5322	116	50527	33,2	1	MR25	METAL FILM
R 1331	5322	116	50572	12,1K	1	MR25	METAL FILM
R 1332	5322	116	50583	5,9K	1	MR25	METAL FILM
R 1333	5322	116	50527	33,2	1	MR25	METAL FILM
R 1334	5322	116	50527	33,2	1	MR25	METAL FILM
R 1335	5322	116	50484	4,64K	1	MR25	METAL FILM
R 1336	5322	116	54898	887	0,25	MR24C	METAL FILM
R 1337	5322	116	50481	22,6K	1	MR25	METAL FILM
R 1338	5322	116	54549	1K	1	MR25	METAL FILM
R 1339	5322	116	50481	22,6K	1	MR25	METAL FILM
R 1341	5322	116	50536	464	1	MR25	METAL FILM
R 1342	5322	116	50481	22,6K	1	MR25	METAL FILM
R 1343	5322	116	54549	1K	1	MR25	METAL FILM
R 1344	5322	116	50954	38,3	1	MR25	METAL FILM
R 1346	4822	116	51253	10K	1	MR25	METAL FILM
R 1347	5322	116	54455	68,1	1	MR25	METAL FILM
R 1348	5322	116	50482	33,2K	1	MR25	METAL FILM
R 1349	5322	116	50581	2,49K	1	MR25	METAL FILM
R 1350	5322	116	54513	332	1	MR25	METAL FILM
R 1351	4822	110	63207	5,6M	10	CR25	CARBON
R 1352	5322	116	54192	5,11	1	MR25	METAL FILM
R 1353	5322	116	50664	2,05K	1	MR25	METAL FILM
R 1354	4822	116	51253	10K	1	MR25	METAL FILM
R 1355	5322	116	50527	33,2	1	MR25	METAL FILM
R 1356	4822	116	51253	10K	1	MR25	METAL FILM
R 1357	5322	116	50479	15,4K	1	MR25	METAL FILM
R 1358	5322	116	50635	1,47K	1	MR25	METAL FILM
R 1359	5322	116	54504	274	1	MR25	METAL FILM
R 1360	5322	116	54547	953	1	MR25	METAL FILM
R 1361	5322	116	54504	274	1	MR25	METAL FILM

R 1362	5322 116 54547	953	1	MR25	METAL FILM
R 1363	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1364	5322 116 54469	100	1	MR25	METAL FILM
R 1365	5322 116 54538	787	1	MR25	METAL FILM
R 1366	5322 116 54561	1,33K	1	MR25	METAL FILM
R 1367	5322 116 54005	3,32K	1	MR25	METAL FILM
R 1368	5322 116 54005	3,32K	1	MR25	METAL FILM
R 1369	5322 116 50671	2,61K	1	MR25	METAL FILM
R 1370	5322 116 54549	1K	1	MR25	METAL FILM
R 1386	5322 116 54508	301	1	MR25	METAL FILM
R 1387	5322 116 50561	590	1	MR25	METAL FILM
R 1388	5322 116 54508	301	1	MR25	METAL FILM
R 1389	5322 116 55278	909	1	MR25	METAL FILM
R 1391	5322 116 55278	909	1	MR25	METAL FILM
R 1392	5322 116 50635	1,47K	1	MR25	METAL FILM
R 1393	5322 116 54536	750	1	MR25	METAL FILM
R 1394	5322 116 54549	1K	1	MR25	METAL FILM
R 1396	5322 116 54508	301	1	MR25	METAL FILM
R 1397	5322 116 54508	301	1	MR25	METAL FILM
R 1398	5322 116 50767	2,15K	1	MR25	METAL FILM
R 1401	5322 116 54901	887K	0,25	MR54C	METAL FILM
R 1402	5322 116 54896	354K	0,25	MR34C	METAL FILM
R 1403	5322 116 54899	176K	0,25	MR34C	METAL FILM
R 1404	5322 116 54897	87,6K	0,25	MR24C	METAL FILM
R 1406	5322 116 54895	34,6K	0,25	MR24C	METAL FILM
R 1407	5322 116 54894	16,8K	0,25	MR24C	METAL FILM
R 1408	5322 116 55161	7,96K	0,25	MR24C	METAL FILM
R 1409	5322 116 50784	2,67K	0,25	MR24C	METAL FILM
R 1411	5322 116 54898	887	0,25	MR24C	METAL FILM
R 1501	5322 116 54549	1K	1	MR25	METAL FILM
R 1502	4822 116 51253	10K	1	MR25	METAL FILM
R 1503	5322 116 50527	33,2	1	MR25	METAL FILM
R 1504	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1506	4822 116 51253	10K	1	MR25	METAL FILM
R 1507	5322 116 54005	3,32K	1	MR25	METAL FILM
R 1508	5322 116 54519	402	1	MR25	METAL FILM
R 1509	5322 116 54005	3,32K	1	MR25	METAL FILM
R 1511	5322 116 54519	402	1	MR25	METAL FILM
R 1512	5322 116 54549	1K	1	MR25	METAL FILM
R 1513	5322 116 54549	1K	1	MR25	METAL FILM
R 1514	4822 116 51253	10K	1	MR25	METAL FILM
R 1515	5322 116 50536	464	1	MR25	METAL FILM
R 1516	4822 116 51253	10K	1	MR25	METAL FILM
R 1517	5322 116 50527	33,2	1	MR25	METAL FILM
R 1518	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1519	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1520	5322 116 54012	6,81K	1	MR25	METAL FILM
R 1521	5322 116 55448	4,02K	1	MR25	METAL FILM
R 1522	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1524	5322 116 50458	7,87K	1	MR25	METAL FILM
R 1525	5322 116 50492	46,4	1	MR25	METAL FILM
R 1526	5322 116 50728	1,87K	1	MR25	METAL FILM
R 1527	5322 116 50527	33,2	1	MR25	METAL FILM
R 1528	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1529	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1531	5322 116 54562	1,4K	1	MR25	METAL FILM
R 1532	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1533	4822 116 51253	10K	1	MR25	METAL FILM
R 1534	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1535	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1536	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1537	5322 100 10141	10K	20	0.75W	TRIMMING POTM
R 1538	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1539	5322 116 54557	1,21K	1	MR25	METAL FILM
R 1541	5322 116 54469	100	1	MR25	METAL FILM
R 1542	5322 116 54557	1,21K	1	MR25	METAL FILM
R 1543	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1550	5322 116 50457	215	1	MR25	METAL FILM
R 1551	5322 116 54538	787	1	MR25	METAL FILM
R 1552	5322 116 54572	2K	1	MR25	METAL FILM

R 1553	5322 116	55359	1,62K	1	MR25	METAL FILM
R 1554	5322 116	54513	332	1	MR25	METAL FILM
R 1555	5322 116	50524	3,01K	1	MR25	METAL FILM
R 1556	5322 116	54683	68,1K	1	MR25	METAL FILM
R 1557	5322 116	54497	226	1	MR25	METAL FILM
R 1558	5322 116	54549	1K	1	MR25	METAL FILM
R 1559	5322 116	54628	13,7K	1	MR25	METAL FILM
R 1561	5322 116	54624	11,5K	1	MR25	METAL FILM
R 1562	5322 116	54513	332	1	MR25	METAL FILM
R 1563	5322 116	54595	5,11K	1	MR25	METAL FILM
R 1564	5322 116	51052	42,2	1	MR25	METAL FILM
R 1566	5322 116	54513	332	1	MR25	METAL FILM
R 1567	5322 116	50664	2,05K	1	MR25	METAL FILM
R 1568	5322 116	50675	2,26K	1	MR25	METAL FILM
R 1569	5322 116	54005	3,32K	1	MR25	METAL FILM
R 1570	5322 116	54469	100	1	MR25	METAL FILM
R 1571	5322 116	54513	332	1	MR25	METAL FILM
R 1572	5322 116	54683	68,1K	1	MR25	METAL FILM
R 1573	5322 116	54484	140	1	MR25	METAL FILM
R 1574	5322 116	50608	6,19K	1	MR25	METAL FILM
R 1576	5322 116	54595	5,11K	1	MR25	METAL FILM
R 1577	5322 116	54513	332	1	MR25	METAL FILM
R 1578	5322 116	51052	42,2	1	MR25	METAL FILM
R 1579	5322 116	54562	1,4K	1	MR25	METAL FILM
R 1581	5322 116	54513	332	1	MR25	METAL FILM
R 1601	4822 116	51233	681	1	MR25	METAL FILM
R 1602	5322 116	55448	4,02K	1	MR25	METAL FILM
R 1603	5322 116	50608	6,19K	1	MR25	METAL FILM
R 1604	5322 116	50484	4,64K	1	MR25	METAL FILM
R 1606	5322 116	55448	4,02K	1	MR25	METAL FILM
R 1607	5322 116	54549	1K	1	MR25	METAL FILM
R 1608	5322 116	54637	17,8K	1	MR25	METAL FILM
R 1609	5322 116	50586	1,54K	1	MR25	METAL FILM
R 1611	5322 116	50586	1,54K	1	MR25	METAL FILM
R 1612	5322 116	54549	1K	1	MR25	METAL FILM
R 1613	5322 116	50664	2,05K	1	MR25	METAL FILM
R 1614	5322 116	50664	2,05K	1	MR25	METAL FILM
R 1615	5322 116	54549	1K	1	MR25	METAL FILM
R 1616	5322 116	54513	332	1	MR25	METAL FILM
R 1617	5322 116	50664	2,05K	1	MR25	METAL FILM
R 1618	5322 116	50664	2,05K	1	MR25	METAL FILM
R 1619	5322 116	54549	1K	1	MR25	METAL FILM
R 1621	5322 116	54549	1K	1	MR25	METAL FILM
R 1622	5322 116	54469	100	1	MR25	METAL FILM
R 1627	5322 116	54596	5,23K	1	MR25	METAL FILM
R 1628	5322 116	54596	5,23K	1	MR25	METAL FILM
R 1629	5322 116	54596	5,23K	1	MR25	METAL FILM
R 1630	5322 116	50452	10	1	MR25	METAL FILM
R 1651	5322 116	54538	787	1	MR25	METAL FILM
R 1652	5322 116	50515	1,78K	1	MR25	METAL FILM
R 1653	5322 116	54632	14,7K	1	MR25	METAL FILM
R 1654	5322 100	10139	4,7K	20	0.75W	TRIMMING POTM
R 1659	5322 116	50579	3,16K	1	MR25	METAL FILM
R 1661	5322 116	50671	2,61K	1	MR25	METAL FILM
R 1664	5322 116	50579	3,16K	1	MR25	METAL FILM
R 1667	5322 116	50527	33,2	1	MR25	METAL FILM
R 1668	5322 116	50527	33,2	1	MR25	METAL FILM
R 1669	5322 116	54538	787	1	MR25	METAL FILM
R 1671	5322 116	50515	1,78K	1	MR25	METAL FILM
R 1672	5322 116	54632	14,7K	1	MR25	METAL FILM
R 1673	5322 100	10139	4,7K	20	0.75W	TRIMMING POTM
R 1678	5322 116	50579	3,16K	1	MR25	METAL FILM
R 1679	5322 116	50527	33,2	1	MR25	METAL FILM
R 1681	5322 116	50527	33,2	1	MR25	METAL FILM
R 1682	5322 116	50671	2,61K	1	MR25	METAL FILM
R 1686	5322 116	50579	3,16K	1	MR25	METAL FILM
R 1701	4822 116	51282	511	1	MR25	METAL FILM
R 1702	5322 116	50561	590	1	MR25	METAL FILM
R 1703	5322 116	50527	33,2	1	MR25	METAL FILM
R 1704	5322 116	50417	162	1	MR25	METAL FILM

R 1706	5322 100 10112	1K	20	0,5W	TRIMMING POTM
R 1707	5322 116 54474	110	1	MR25	METAL FILM
R 1708	5322 116 50581	2,49K	1	MR25	METAL FILM
R 1709	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1710	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1711	5322 116 50732	549	1	MR25	METAL FILM
R 1712	5322 116 50732	549	1	MR25	METAL FILM
R 1713	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1714	4822 116 51253	10K	1	MR25	METAL FILM
R 1716	5322 116 50592	442	1	MR25	METAL FILM
R 1718	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1719	5322 116 50491	22,6	1	MR25	METAL FILM
R 1721	5322 116 50527	33,2	1	MR25	METAL FILM
R 1722	5322 116 54701	110K	1	MR25	METAL FILM
R 1723	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1724	5322 116 54696	100K	1	MR25	METAL FILM
R 1726	5322 116 54641	19,6K	1	MR25	METAL FILM
R 1727	5322 116 50671	2,61K	1	MR25	METAL FILM
R 1728	5322 116 54532	649	1	MR25	METAL FILM
R 1729	5322 116 54462	82,5	1	MR25	METAL FILM
R 1731	4822 116 51253	10K	1	MR25	METAL FILM
R 1732	4822 116 51282	511	1	MR25	METAL FILM
R 1733	5322 116 54549	1K	1	MR25	METAL FILM
R 1734	5322 116 54519	402	1	MR25	METAL FILM
R 1736	5322 116 54723	187K	1	MR25	METAL FILM
R 1737	5322 101 14094	1M	20	0,5W	TRIMMING POTM
R 1738	5322 116 54549	1K	1	MR25	METAL FILM
R 1739	5322 116 54519	402	1	MR25	METAL FILM
R 1741	5322 116 54723	187K	1	MR25	METAL FILM
R 1742	4822 116 51282	511	1	MR25	METAL FILM
R 1743	5322 116 54462	82,5	1	MR25	METAL FILM
R 1744	4822 116 51253	10K	1	MR25	METAL FILM
R 1746	5322 116 54606	7,15K	1	MR25	METAL FILM
R 1747	5322 116 54532	649	1	MR25	METAL FILM
R 1748	4822 116 51253	10K	1	MR25	METAL FILM
R 1749	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1801	5322 116 54743	301K	1	MR25	METAL FILM
R 1802	5322 116 54743	301K	1	MR25	METAL FILM
R 1803	4822 110 42187	1M	5	VR37	CARBON
R 1804	4822 112 21121	3,3K	5	4W	WIRE-WOUND
R 1806	5322 116 34051				NTC
R 1807	5322 116 54935	82,5K	0,5	MR30	METAL FILM
R 1808	5322 116 54935	82,5K	0,5	MR30	METAL FILM
R 1809	5322 116 54935	82,5K	0,5	MR30	METAL FILM
R 1811	5322 116 55478	1,2	0,5	MR25	METAL FILM
R 1812	5322 116 54469	100	1	MR25	METAL FILM
R 1813	5322 116 50491	22,6	1	MR25	METAL FILM
R 1814	5322 116 54351	20	5	PR52	METAL FILM
R 1816	5322 116 55205	2K	5	PR52	METAL FILM
R 1817	4822 110 63214	10M	10	CR25	CARBON
R 1818	4822 110 63214	10M	10	CR25	CARBON
R 1819	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1822	5322 116 50629	1,74K	1	MR25	METAL FILM
R 1823	5322 116 54696	100K	1	MR25	METAL FILM
R 1824	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1826	5322 100 10135	470	20	0.75W	TRIMMING POTM
R 1827	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1828	5322 116 54623	11K	1	MR25	METAL FILM
R 1829	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1830	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1831	5322 116 50583	5,9K	1	MR25	METAL FILM
R 1832	5322 116 54005	3,32K	1	MR25	METAL FILM
R 1833	5322 116 54012	6,81K	1	MR25	METAL FILM
R 1834	5322 116 54499	249	1	MR25	METAL FILM
R 1836	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1837	5322 116 54499	249	1	MR25	METAL FILM
R 1838	5322 116 54484	140	1	MR25	METAL FILM
R 1839	4822 110 63027	1	5	CR25	CARBON
R 1846	5322 116 54704	121K	1	MR25	METAL FILM
R 1847	5322 116 54704	121K	1	MR25	METAL FILM

R 1848	4822	110	63187	1M	5	CR25	CARBON
R 1849	4822	116	51253	10K	1	MR25	METAL FILM
R 1851	5322	116	54683	68,1K	1	MR25	METAL FILM
R 1852	5322	116	54386	249K	1	MR25	METAL FILM
R 1853	5322	116	55258	511K	1	MR25	METAL FILM
R 1854	4822	110	63187	1M	5	CR25	CARBON
R 1856	5322	116	54561	1,33K	1	MR25	METAL FILM
R 1857	5322	116	54561	1,33K	1	MR25	METAL FILM
R 1858	5322	116	54549	1K	1	MR25	METAL FILM
R 1861	4822	110	42214	10M	5	VR37	CARBON
R 1873	5322	116	54518	383	1	MR25	METAL FILM
R 1874	5322	116	54518	383	1	MR25	METAL FILM
R 1876	5322	116	54469	100	1	MR25	METAL FILM
R 1901	5322	116	54462	82,5	1	MR25	METAL FILM
R 1902	5322	116	54641	19,6K	1	MR25	METAL FILM
R 1903	5322	116	50608	6,19K	1	MR25	METAL FILM
R 1904	5322	116	54511	316	1	MR25	METAL FILM
R 1906	5322	100	10113	10K	20	0,5W	TRIMMING POTM
R 1907	5322	116	54536	750	1	MR25	METAL FILM
R 1908	5322	116	54561	1,33K	1	MR25	METAL FILM
R 1909	5322	116	50608	6,19K	1	MR25	METAL FILM
R 1911	5322	116	54549	1K	1	MR25	METAL FILM
R 1912	5322	116	54469	100	1	MR25	METAL FILM
R 1913	5322	116	54549	1K	1	MR25	METAL FILM
R 2001	5322	116	54567	1,69K	1	MR25	METAL FILM
R 2002	5322	116	51052	42,2	1	MR25	METAL FILM
R 2003	5322	116	51052	42,2	1	MR25	METAL FILM
R 2004	5322	116	50491	22,6	1	MR25	METAL FILM
R 2006	4822	116	51253	10K	1	MR25	METAL FILM
R 2007	5322	116	50481	22,6K	1	MR25	METAL FILM
R 2008	4822	116	51282	511	1	MR25	METAL FILM
R 2009	5322	116	50671	2,61K	1	MR25	METAL FILM
R 2011	5322	116	54567	1,69K	1	MR25	METAL FILM
R 2014	5322	116	50484	4,64K	1	MR25	METAL FILM
R 2016	5322	116	54005	3,32K	1	MR25	METAL FILM
R 2017	5322	116	50536	464	1	MR25	METAL FILM
R 2018	5322	116	50664	2,05K	1	MR25	METAL FILM
R 2019	5322	116	50669	205	1	MR25	METAL FILM
R 2021	5322	116	50572	12,1K	1	MR25	METAL FILM
R 2022	5322	116	54536	750	1	MR25	METAL FILM
R 2023	5322	116	54557	1,21K	1	MR25	METAL FILM
R 2024	5322	116	50583	5,9K	1	MR25	METAL FILM
R 2026	5322	116	50491	22,6	1	MR25	METAL FILM
R 2027	5322	116	50491	22,6	1	MR25	METAL FILM
R 2028	5322	116	50572	12,1K	1	MR25	METAL FILM
R 2029	5322	116	54009	562	1	MR25	METAL FILM
R 2030	5322	116	54549	1K	1	MR25	METAL FILM
R 2031	5322	116	54683	68,1K	1	MR25	METAL FILM
R 2032	5322	116	55448	4,02K	1	MR25	METAL FILM
R 2033	5322	116	54549	1K	1	MR25	METAL FILM
R 2034	5322	116	54469	100	1	MR25	METAL FILM
R 2037	5322	101	14094	1M	20	0,5W	TRIMMING POTM
R 2038	5322	116	50491	22,6	1	MR25	METAL FILM
R 2039	5322	101	14094	1M	20	0,5W	TRIMMING POTM
R 2041	5322	116	54549	1K	1	MR25	METAL FILM
R 2042	5322	116	54549	1K	1	MR25	METAL FILM
R 2043	5322	116	50482	33,2K	1	MR25	METAL FILM
R 2044	5322	116	50491	22,6	1	MR25	METAL FILM
R 2046	5322	116	54692	86,6K	1	MR25	METAL FILM
R 2047	5322	116	54743	301K	1	MR25	METAL FILM
R 2048	5322	101	14071	100K	20	0,5W	TRIMMING POTM
R 2049	5322	116	50481	22,6K	1	MR25	METAL FILM
R 2050	4822	116	51253	10K	1	MR25	METAL FILM
R 2051	4822	110	42218	15M	5	VR37	CARBON
R 2052	5322	116	54595	5,11K	1	MR25	METAL FILM
R 2053	5322	116	54595	5,11K	1	MR25	METAL FILM
R 2054	5322	116	54549	1K	1	MR25	METAL FILM
R 2056	5322	116	50558	18,7K	1	MR25	METAL FILM
R 2057	5322	116	54678	59K	1	MR25	METAL FILM
R 2058	5322	116	54743	301K	1	MR25	METAL FILM

R 2059	5322	116	50536	464	1	MR25	METAL FILM
R 2060	4822	110	42223	22M	5	VR37	CARBON
R 2061	5322	116	54561	1,33K	1	MR25	METAL FILM
R 2062	5322	116	54696	100K	1	MR25	METAL FILM
R 2063	5322	116	50491	22,6	1	MR25	METAL FILM
R 2064	5322	116	54683	68,1K	1	MR25	METAL FILM
R 2065	5322	116	54696	100K	1	MR25	METAL FILM
R 2067	5322	116	50572	12,1K	1	MR25	METAL FILM
R 2068	5322	116	50491	22,6	1	MR25	METAL FILM
R 2069	5322	116	54678	59K	1	MR25	METAL FILM
R 2071	5322	101	14071	100K	20	0.5W	TRIMMING POTM
R 2072	4822	110	42214	10M	5	VR37	CARBON
R 2073	4822	110	42218	15M	5	VR37	CARBON
R 2077	4822	116	51253	10K	1	MR25	METAL FILM
R 2078	4822	110	63187	1M	5	CR25	CARBON
R 2079	4822	110	63187	1M	5	CR25	CARBON
R 2081	5322	116	54549	1K	1	MR25	METAL FILM
R 2082	5322	116	54549	1K	1	MR25	METAL FILM
R 2083	5322	116	54743	301K	1	MR25	METAL FILM
R 2084	5322	116	55284	681K	1	MR25	METAL FILM
R 2086	4822	116	51253	10K	1	MR25	METAL FILM
R 2087	5322	116	54469	100	1	MR25	METAL FILM
R 2088	5322	116	54696	100K	1	MR25	METAL FILM
R 2089	5322	116	54696	100K	1	MR25	METAL FILM
R 2090	5322	116	55599	1,96	0,5	MR30	METAL FILM
R 2091	5322	116	50491	22,6	1	MR25	METAL FILM
R 2092	5322	116	50491	22,6	1	MR25	METAL FILM
R 2093	5322	116	50491	22,6	1	MR25	METAL FILM
R 2094	5322	116	50491	22,6	1	MR25	METAL FILM
R 2095	4822	116	51253	10K	1	MR25	METAL FILM
R 2096	5322	116	50491	22,6	1	MR25	METAL FILM
R 2097	5322	116	50491	22,6	1	MR25	METAL FILM
R 2098	5322	116	50479	15,4K	1	MR25	METAL FILM
R 2099	5322	116	50527	33,2	1	MR25	METAL FILM
R 2100	5322	116	50527	33,2	1	MR25	METAL FILM
R 2101	5322	116	54504	274	1	MR25	METAL FILM
R 2201	5322	111	94157	270	2	4X0.3W	WIRE-WOUND
R 2202	5322	111	94157	270	2	4X0.3W	WIRE-WOUND
R 2203	5322	111	94158	180	5	8X0.2W	WIRE-WOUND
R 2204	5322	116	50491	22,6	1	MR25	METAL FILM
R 2206	5322	116	50491	22,6	1	MR25	METAL FILM
R 2207	5322	116	50491	22,6	1	MR25	METAL FILM
R 2208	5322	116	50491	22,6	1	MR25	METAL FILM
R 2209	5322	116	50491	22,6	1	MR25	METAL FILM
R 2211	5322	116	50491	22,6	1	MR25	METAL FILM
R 2212	5322	116	50491	22,6	1	MR25	METAL FILM
R 2213	5322	116	50491	22,6	1	MR25	METAL FILM
R 2214	5322	116	54476	115	1	MR25	METAL FILM
R 2216	5322	116	50457	215	1	MR25	METAL FILM
R 2217	5322	111	94158	180	5	8X0.2W	WIRE-WOUND
R 2218	5322	116	54678	59K	1	MR25	METAL FILM
R 2219	5322	111	94157	270	2	4X0.3W	WIRE-WOUND
R 2221	5322	111	94157	270	2	4X0.3W	WIRE-WOUND
R 2301	5322	111	94152	1K	2	4X0.3W	WIRE-WOUND
R 2302	5322	100	10143	1K	20	0.75W	TRIMMING POTM
R 2303	5322	111	94153	4,7K	2	4X0.3W	WIRE-WOUND
R 2306	5322	111	94154	10K	2	4X0.3W	WIRE-WOUND
R 2307	5322	111	44204	22M	5	0.125W	CARBON
R 2308	5322	111	44205	300K	5	0.125W	CARBON
R 2311	5322	111	94155	100K	2	4X0.3W	WIRE-WOUND
R 2312	5322	111	94155	100K	2	4X0.3W	WIRE-WOUND
R 2313	5322	100	10139	4,7K	20	0.75W	TRIMMING POTM
R 2316	5322	116	64075	20K	5	0.125W	METAL OXIDE
R 2317	4822	116	51123	1K	5	0.125W	METAL FILM
R 2318	5322	116	64076	620	5	0.125W	METAL OXIDE
R 2321	5322	100	10135	470	20	0.75W	TRIMMING POTM
R 2322	5322	111	94154	10K	2	4X0.3W	WIRE-WOUND
R 2323	5322	116	64077	1,3K	5	0.125W	METAL OXIDE
R 2324	5322	116	50452	10	1	MR25	METAL FILM
R 2401	5322	111	94156	4,7K	5	8X0.2W	WIRE-WOUND

R 2402	5322 116	54192	5,11	1	MR25	METAL FILM
R 2403	5322 116	54469	100	1	MR25	METAL FILM
R 2407	5322 116	54504	274	1	MR25	METAL FILM
R 2408	5322 116	54484	140	1	MR25	METAL FILM
R 2411	5322 116	50515	1,78K	1	MR25	METAL FILM
R 2412	5322 116	50675	2,26K	1	MR25	METAL FILM
R 2413	5322 116	54532	649	1	MR25	METAL FILM
R 2416	5322 116	54532	649	1	MR25	METAL FILM
R 2417	5322 116	50608	6,19K	1	MR25	METAL FILM
R 2418	5322 116	54504	274	1	MR25	METAL FILM
R 2419	5322 116	54504	274	1	MR25	METAL FILM
R 2421	5322 116	54547	953	1	MR25	METAL FILM
R 2422	5322 116	54549	1K	1	MR25	METAL FILM
R 2423	5322 116	50561	590	1	MR25	METAL FILM
R 2424	5322 116	54504	274	1	MR25	METAL FILM
R 2426	5322 116	50561	590	1	MR25	METAL FILM
R 2427	5322 116	54562	1,4K	1	MR25	METAL FILM
R 2428	5322 116	54012	6,81K	1	MR25	METAL FILM
R 2431	5322 116	54513	332	1	MR25	METAL FILM
R 2432	5322 116	54469	100	1	MR25	METAL FILM
R 2433	5322 116	50636	2,74K	1	MR25	METAL FILM
R 2436	5322 116	50484	4,64K	1	MR25	METAL FILM
R 2437	5322 116	50669	205	1	MR25	METAL FILM
R 2438	5322 116	54549	1K	1	MR25	METAL FILM
R 2439	5322 116	54192	5,11	1	MR25	METAL FILM
R 2441	5322 116	54504	274	1	MR25	METAL FILM
R 2442	5322 116	54484	140	1	MR25	METAL FILM
R 2443	5322 116	54504	274	1	MR25	METAL FILM
R 2451	5322 111	94156	4,7K	5	8X0.2W	WIRE-WOUND
R 2461	5322 111	94156	4,7K	5	8X0.2W	WIRE-WOUND
R 2471	5322 111	94156	4,7K	5	8X0.2W	WIRE-WOUND
R 2482	5322 116	50484	4,64K	1	MR25	METAL FILM
R 2484	5322 116	50484	4,64K	1	MR25	METAL FILM
R 2487	5322 116	54504	274	1	MR25	METAL FILM
R 2488	5322 116	54595	5,11K	1	MR25	METAL FILM
R 2489	5322 116	54678	59K	1	MR25	METAL FILM
R 2494	5322 116	54504	274	1	MR25	METAL FILM
R 2495	5322 116	54012	6,81K	1	MR25	METAL FILM
R 2496	4822 116	51253	10K	1	MR25	METAL FILM
R 2497	5322 116	54648	24,9K	1	MR25	METAL FILM
R 2501	5322 116	50482	33,2K	1	MR25	METAL FILM
R 2502	5322 116	54549	1K	1	MR25	METAL FILM
R 2503	5322 116	50675	2,26K	1	MR25	METAL FILM
R 2551	5322 116	50669	205	1	MR25	METAL FILM
R 2552	5322 116	54489	169	1	MR25	METAL FILM
R 2600	5322 116	54469	100	1	MR25	METAL FILM
R 2601	5322 116	50664	2,05K	1	MR25	METAL FILM
R 2602	5322 100	10141	10K	20	0.75W	TRIMMING POTM
R 2603	5322 116	54549	1K	1	MR25	METAL FILM
R 2604	5322 116	55266	10,2K	0,1	MR24E	METAL FILM
R 2605	5322 116	54549	1K	1	MR25	METAL FILM
R 2606	5322 100	10135	470	20	0.75W	TRIMMING POTM
R 2607	5322 116	50748	10K	0,1	MR24E	METAL FILM
R 2608	5322 116	50818	44,2	1	MR25	METAL FILM
R 2609	5322 116	54696	100K	1	MR25	METAL FILM
R 2611	5322 116	54696	100K	1	MR25	METAL FILM
R 2612	5322 116	54696	100K	1	MR25	METAL FILM
R 2613	5322 100	10141	10K	20	0.75W	TRIMMING POTM
R 2614	5322 116	54549	1K	1	MR25	METAL FILM
R 2616	5322 116	55266	10,2K	0,1	MR24E	METAL FILM
R 2617	5322 100	10135	470	20	0.75W	TRIMMING POTM
R 2618	5322 116	50748	10K	0,1	MR24E	METAL FILM
R 2619	5322 116	50818	44,2	1	MR25	METAL FILM
R 2621	5322 116	54696	100K	1	MR25	METAL FILM
R 2622	5322 116	54696	100K	1	MR25	METAL FILM
R 2623	5322 116	54696	100K	1	MR25	METAL FILM
R 2624	5322 116	50748	10K	0,1	MR24E	METAL FILM
R 2626	5322 100	10138	100	20	0.75W	TRIMMING POTM
R 2627	5322 116	50748	10K	0,1	MR24E	METAL FILM
R 2628	5322 116	50664	2,05K	1	MR25	METAL FILM

R 2629	5322	116	50748	10K	0,1	MR24E	METAL	FILM
R 2630	5322	116	50664	2,05K	1	MR25	METAL	FILM
R 2631	5322	116	50748	10K	0,1	MR24E	METAL	FILM
R 2632	5322	116	50579	3,16K	1	MR25	METAL	FILM
R 2633	5322	116	54595	5,11K	1	MR25	METAL	FILM
R 2634	5322	116	54549	1K	1	MR25	METAL	FILM
R 2636	5322	116	54549	1K	1	MR25	METAL	FILM
R 2637	5322	116	54595	5,11K	1	MR25	METAL	FILM
R 2638	5322	116	54549	1K	1	MR25	METAL	FILM
R 2639	5322	116	54549	1K	1	MR25	METAL	FILM
R 2641	5322	116	50579	3,16K	1	MR25	METAL	FILM
R 2642	5322	116	50904	30,1	1	MR25	METAL	FILM
R 2643	5322	116	50904	30,1	1	MR25	METAL	FILM
R 2644	4822	116	51253	10K	1	MR25	METAL	FILM
R 2653	5322	116	54012	6,81K	1	MR25	METAL	FILM
R 2654	5322	116	54549	1K	1	MR25	METAL	FILM
R 2661	5322	116	50679	237	1	MR25	METAL	FILM
R 2662	5322	116	54442	51,1	1	MR25	METAL	FILM
R 2663	5322	116	54508	301	1	MR25	METAL	FILM
R 2664	5322	116	54426	121	1	MR25	METAL	FILM
R 2666	5322	116	54504	274	1	MR25	METAL	FILM
R 2667	5322	116	50452	10	1	MR25	METAL	FILM
R 2668	5322	116	50452	10	1	MR25	METAL	FILM
R 2669	5322	116	54549	1K	1	MR25	METAL	FILM
R 2671	5322	116	50664	2,05K	1	MR25	METAL	FILM
R 2672	5322	116	50484	4,64K	1	MR25	METAL	FILM
R 2673	5322	116	54589	3,83K	1	MR25	METAL	FILM
R 2674	5322	116	50664	2,05K	1	MR25	METAL	FILM
R 2676	5322	116	54469	100	1	MR25	METAL	FILM
R 2677	4822	116	51253	10K	1	MR25	METAL	FILM
R 2678	5322	116	50664	2,05K	1	MR25	METAL	FILM
R 2679	5322	116	54504	274	1	MR25	METAL	FILM
R 2681	5322	116	54504	274	1	MR25	METAL	FILM

Item	Ordering number	Type/description
Semi Conductors		
V 1	5322 131 24047	D14-302 GH/95 P H
V 2	4822 130 31144	CQY24B-III PH
V 3	4822 130 31144	CQY24B-III PH
V 4	4822 130 31144	CQY24B-III PH
V 5	4822 130 31144	CQY24B-III PH
V 6	4822 130 31144	CQY24B-III PH
V 7	4822 130 31144	CQY24B-III PH
V 8	5322 130 34811	FND367 FA
V 9	5322 130 34811	FND367 FA
V 10	5322 130 34811	FND367 FA
V 11	5322 130 34811	FND367 FA
V 12	5322 130 34811	FND367 FA
V 13	5322 130 34811	FND367 FA
V 14	4822 130 30914	CQY54 PH
V 15	4822 130 30914	CQY54 PH
V 16	4822 130 30914	CQY54 PH
V 101	5322 130 34037	BAV45 PH
V 102	5322 130 44797	ON471 PH
V 103	5322 130 44459	BFT25R PH
V 104	5322 130 44178	BFR92 PH
V 151	5322 130 34037	BAV45 PH
V 152	5322 130 44797	ON471 PH
V 153	5322 130 44458	BFT25 PH
V 154	5322 130 44606	BFR92R PH
V 201	4822 130 30613	BAW62 PH
V 202	4822 130 30613	BAW62 PH
V 203	5322 130 44711	BFT92 PH
V 204	5322 130 44713	BFT92R PH
V 206	5322 130 34331	BAV70 PH
V 207	5322 130 34331	BAV70 PH
V 208	4822 130 34047	BZX75-C1V4 PH
V 209	4822 130 30613	BAW62 PH
V 211	4822 130 30613	BAW62 PH
V 212	4822 130 30613	BAW62 PH
V 213	4822 130 30613	BAW62 PH
V 214	5322 130 44337	BCW33 PH
V 216	5322 130 44335	BCW30 PH
V 220	4822 130 30613	BAW62 PH
V 221	4822 130 30613	BAW62 PH
V 301	4822 130 30613	BAW62 PH
V 302	4822 130 30613	BAW62 PH
V 303	5322 130 44711	BFT92 PH
V 304	5322 130 44713	BFT92R PH
V 306	5322 130 34331	BAV70 PH
V 307	5322 130 34331	BAV70 PH
V 308	4822 130 34047	BZX75-C1V4 PH
V 309	4822 130 30613	BAW62 PH
V 311	4822 130 30613	BAW62 PH
V 312	4822 130 30613	BAW62 PH
V 313	4822 130 30613	BAW62 PH
V 314	5322 130 44342	BCW33R PH
V 316	5322 130 44341	BCW30R PH
V 320	4822 130 30613	BAW62 PH
V 321	4822 130 30613	BAW62 PH
V 401	5322 130 44337	BCW33 PH
V 402	4822 130 34233	BZX79-C5V1 PH
V 403	5322 130 34331	BAV70 PH
V 404	5322 130 34331	BAV70 PH
V 406	4822 130 34047	BZX75-C1V4 PH
V 407	5322 130 44335	BCW30 PH
V 408	5322 130 44337	BCW33 PH
V 409	5322 130 44337	BCW33 PH
V 451	5322 130 44342	BCW33R PH
V 452	4822 130 34233	BZX79-C5V1 PH
V 453	5322 130 34331	BAV70 PH
V 454	5322 130 34331	BAV70 PH
V 456	4822 130 34047	BZX75-C1V4 PH
V 457	5322 130 44341	BCW30R PH

V 458	5322	130	44342	BCW33R	PH
V 500	4822	130	30613	BAW62	PH
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Item	Ordering number	Type/Description	Ohm	Tol (%)
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D 102	5322 116 94021	METAL FILM	TF CIRC	UIT
D 151	5322 209 85475	LM208H	SC	
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D 201	5322 209 85484	0Q 0012		
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D 701	5322 209 84659	LM308T	PH	
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D 1606	5322 209 84823	N74LS00N	SC	
D 1607	5322 209 84823	N74LS00N	SC	
D 1608	5322 209 84823	N74LS00N	SC	
D 1609	5322 209 85527	N74LS76N	SC	
D 1611	5322 209 86076	SN74LS27N-00	T	
D 1612	5322 209 84995	N74LS08N	SC	
D 1651	5322 209 85899	LM324N	SC	
D 1801	5322 209 85662	TDA1060	PH	
D 1876	5322 209 84342	UA741CH	SC	
D 1901	5322 209 84452	UA709CH	SC	
D 2201	5322 209 85269	N74LS75N	SC	
D 2202	5322 209 85269	N74LS75N	SC	
D 2203	5322 209 86007	SN74LS259N-00	T	
D 2301	4822 209 80416	LM339A	SC	
D 2302	5322 209 85265	N74LS03N	SC	
D 2401	5322 209 86474	GXB10231P	SC	
D2402	5322 209 86477			

D 2403	5322 209 86476	GXB10104P	SC
D 2404	5322 209 85602	N74LS123N	SC
D 2406	5322 209 85491	N74LS190N	SC
D 2407	5322 209 85491	N74LS190N	SC
D 2408	5322 209 84995	N74LS08N	SC
D 2409	5322 209 85491	N74LS190N	SC
D 2411	5322 209 85491	N74LS190N	SC
D 2412	5322 209 84995	N74LS08N	SC
D 2413	5322 209 85269	N74LS75N	SC
D 2414	5322 209 85269	N74LS75N	SC
D 2416	5322 209 85269	N74LS75N	SC
D 2417	5322 209 85269	N74LS75N	SC
D 2418	5322 209 85269	N74LS75N	SC
D 2419	5322 209 86475	GXB10102D	SC
D 2451	5322 209 85667	N74LS253N	SC
D 2452	5322 209 85667	N74LS253N	SC
D 2453	5322 209 85667	N74LS253N	SC
D 2457	5322 209 84823	N74LS00N	SC
D 2458	5322 209 85602	N74LS123N	SC
D 2601	5322 209 84989	N74LS191N	SC
D 2602	5322 209 85491	N74LS190N	SC
D 2603	5322 209 85491	N74LS190N	SC
D 2604	5322 209 85491	N74LS190N	SC
D 2606	5322 209 85486	N74LS04N	SC
D 2607	5322 209 85505	N74LS22N	SC
D 2608	5322 209 84823	N74LS00N	SC
D 2609	5322 209 14072	HEF4044BP	PH
D 2611	5322 209 84659	LM308T	PH
D 2612	5322 209 84659	LM308T	PH
D 2613	5322 209 84659	LM308T	PH
D 2617	5322 209 84823	N74LS00N	SC
D 2618	5322 209 84459	N7470N	SC
D 2652	5322 209 54421	GEPROMMEERD	
D 2653	5322 209 14835	2111A-4N	SC
D 2654	5322 209 14835	2111A-4N	SC
D 2656	5322 209 85727	N8T28N	SC
D 2657	5322 209 85727	N8T28N	SC
D 2659	5322 209 84823	N74LS00N	SC
D 2661	5322 209 84995	N74LS08N	SC
D 2662	5322 209 85486	N74LS04N	SC
D 2663	5322 209 84823	N74LS00N	SC
D 2664	5322 209 85269	N74LS75N	SC
D 2666	5322 209 85269	N74LS75N	SC
D 2667	5322 209 86035	P8085A	IN
D 2668	5322 209 85353	N8T97N	SC
D 2669	5322 209 84823	N74LS00N	SC
D 2671	5322 209 84986	SN74LS74N-00	T

Item	Ordering number			Type/Description	
Miscellaneous					
B 2601	4822	242	70325	CRYSTAL	4MC
E 1	5322	134	44177		
F 1	4822	253	30025		
K 1701	5322	280	24126	COIL	
L 801	5322	152	24069		
L 1801	5322	156	14076		
L 1802	5322	156	14076	COIL	
L 1803	5322	142	44026	COIL	
L 1804	5322	281	64154	COIL	
L 1806	5322	148	84041		
L 1807	5322	152	24062		
L 1811	4822	156	20663	COIL	
L 1812	4822	156	20663	COIL	
L 1813	4822	156	20663	COIL	
L 1814	4822	156	20663	COIL	
L 1816	5322	152	24067	COIL	
L 1817	5322	152	24068		
L 1876	5322	152	24069		
L 1877	5322	156	14076	COIL	
L 1878	5322	152	24069		
S 1801	5322	277	24071		
S 2601	5322	277	24045	SWITCH	SAM
T 1801	5322	148	84039		
T 1876	5322	146	14171		

12. CIRCUIT DIAGRAMS AND PRINTED CIRCUIT BOARD LAY-OUTS

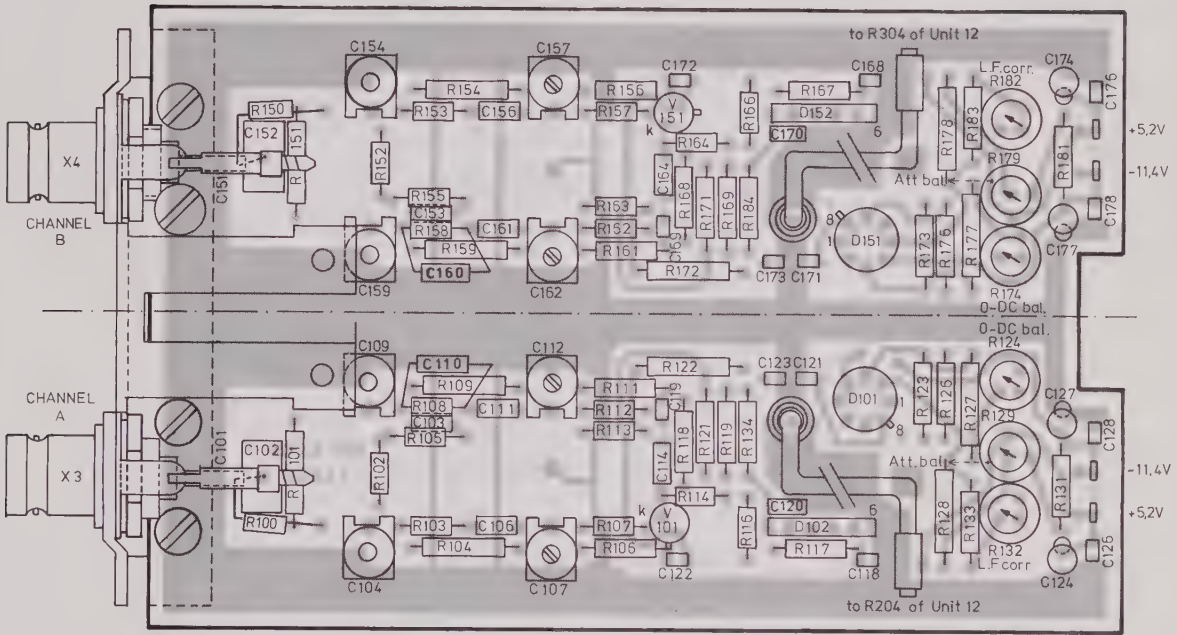
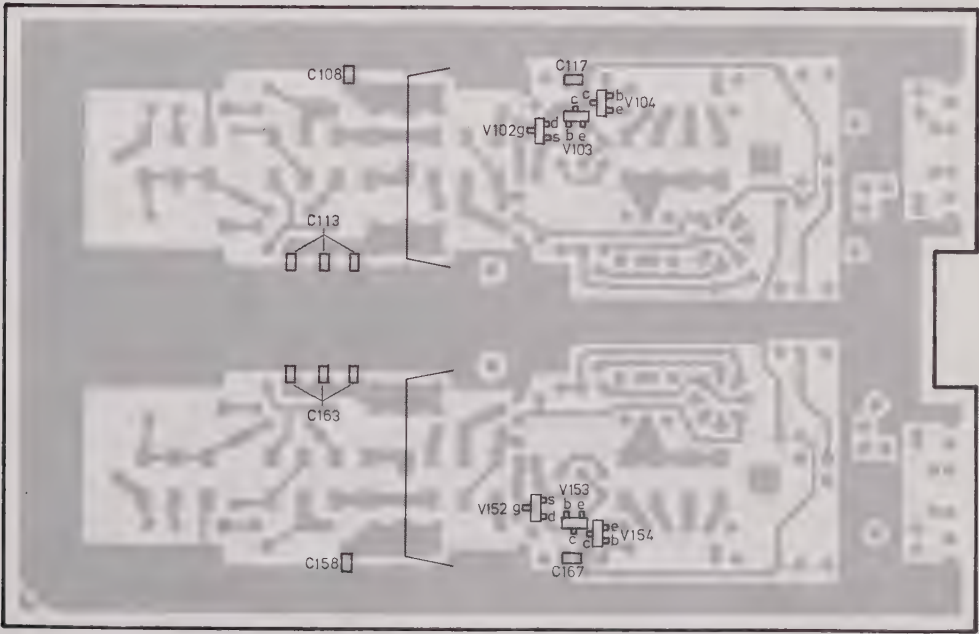


Fig. 12.1. Vertical attenuator component side (UNIT 2)

MAT 47 A



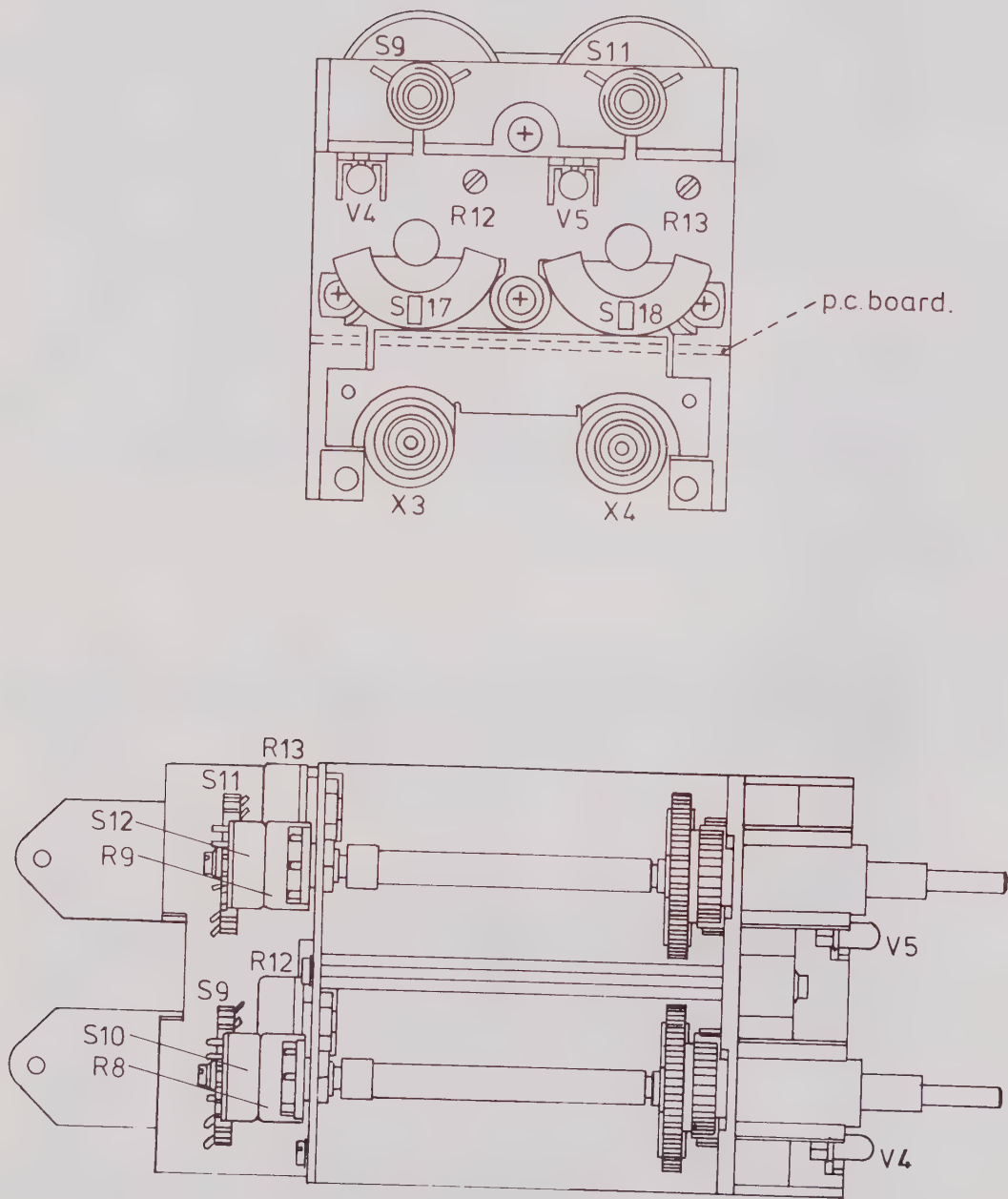
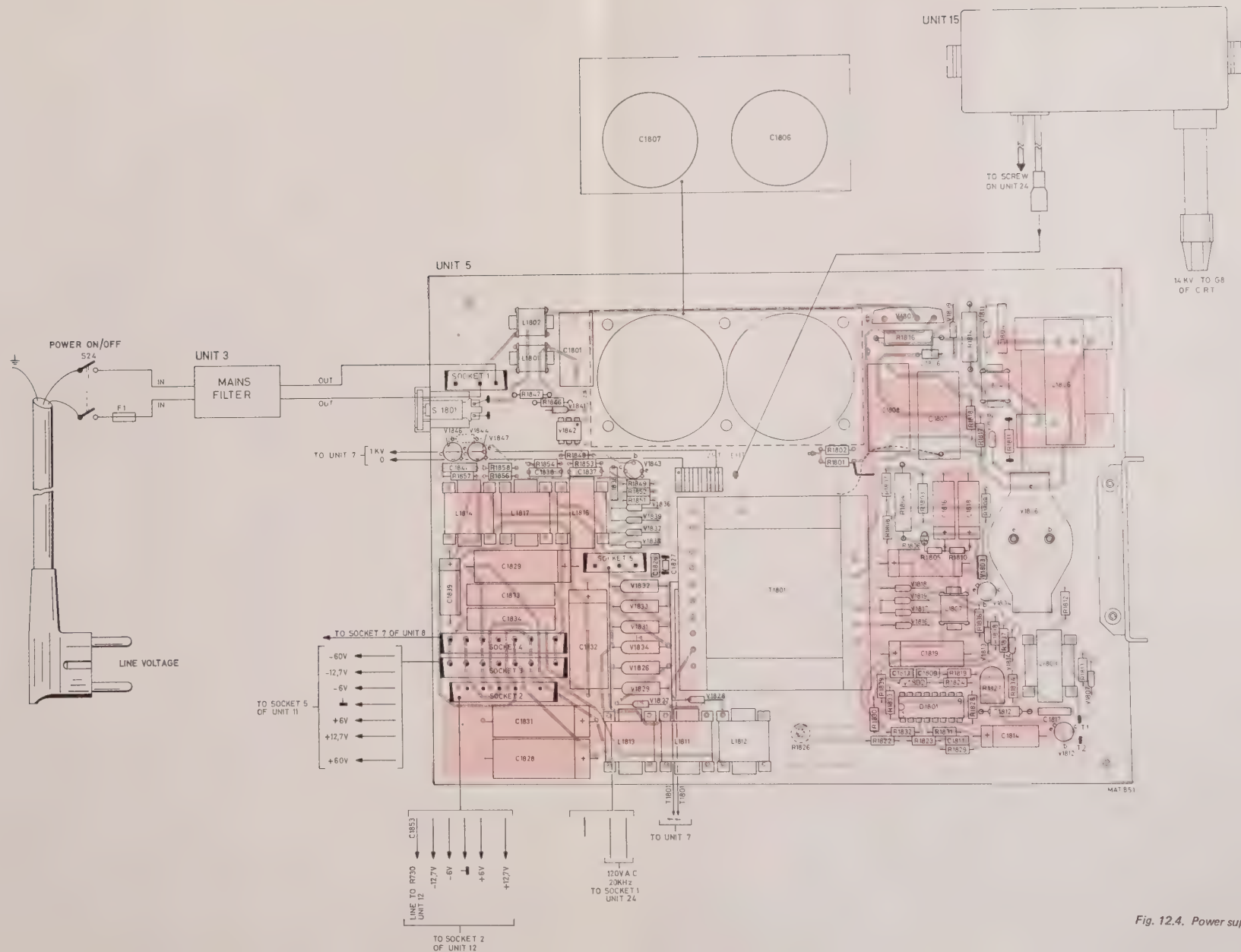


Fig. 12.3. Vertical attenuator (UNIT 2)



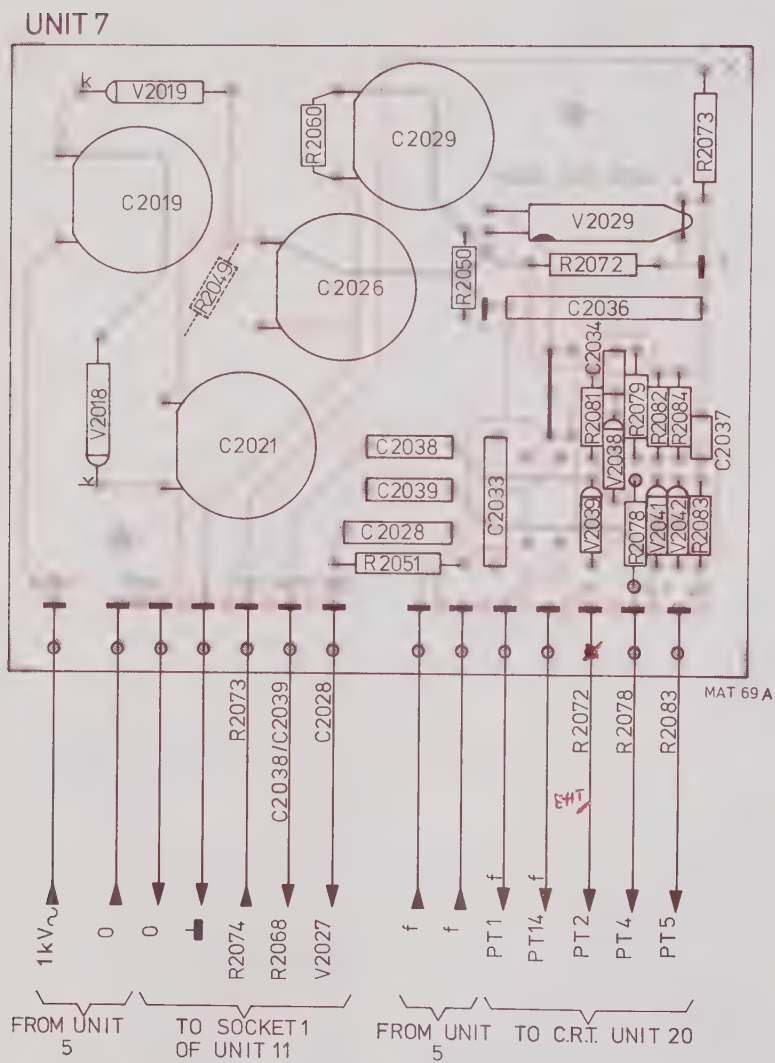


Fig. 12.5. Focus unit (UNIT 7)

Fig. 12.6. Main and delayed time-base (UNIT 8)

Fig. 12.7. MTB and DTB trigger unit (UNIT 9)

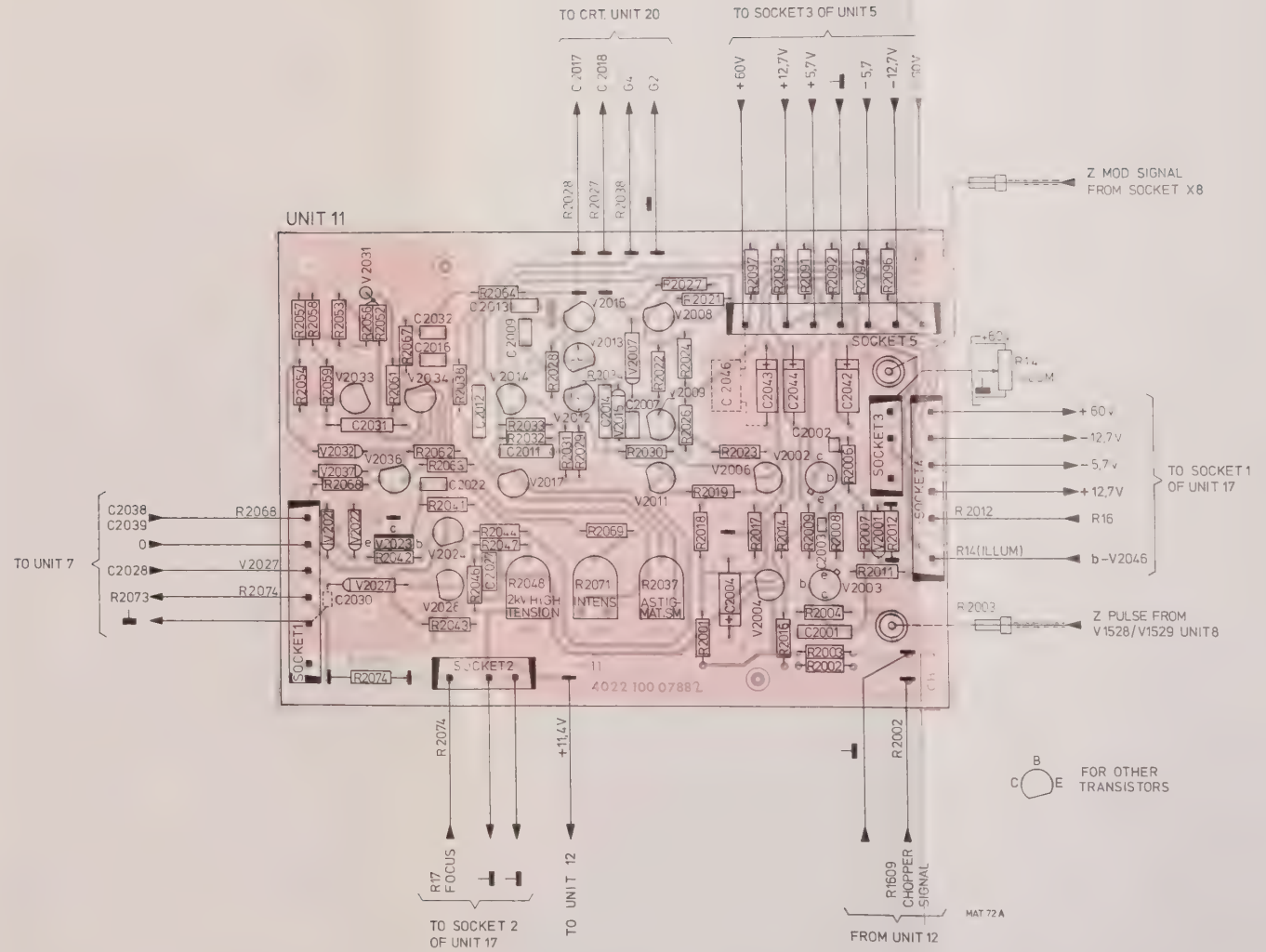
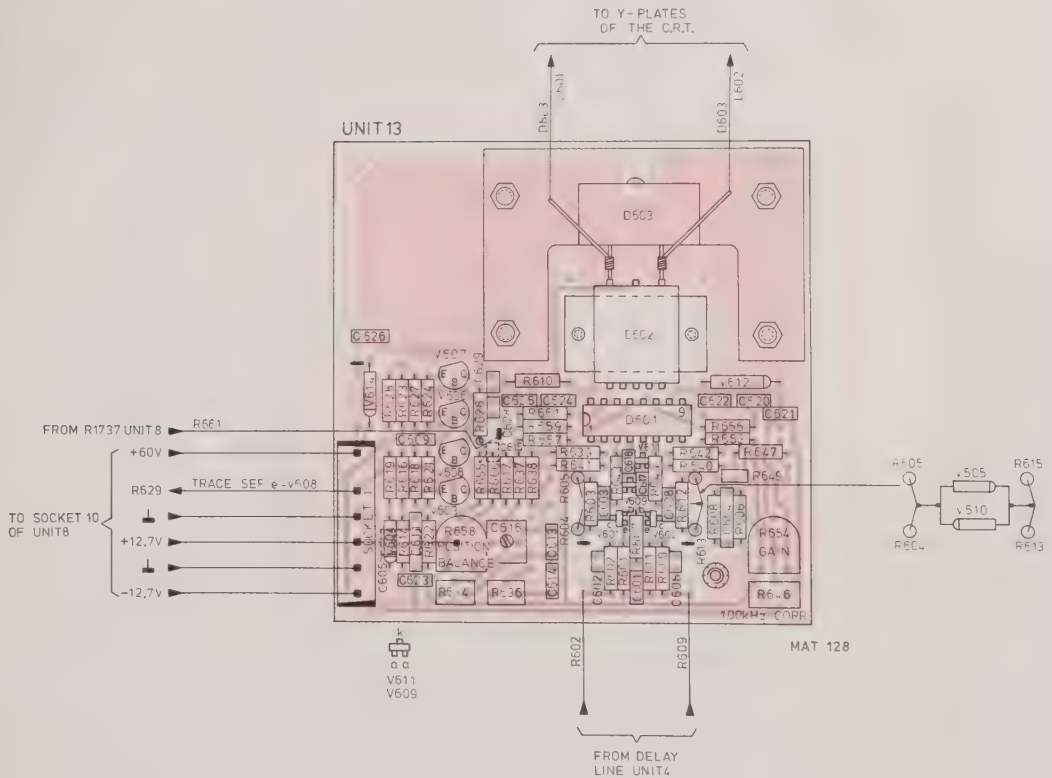
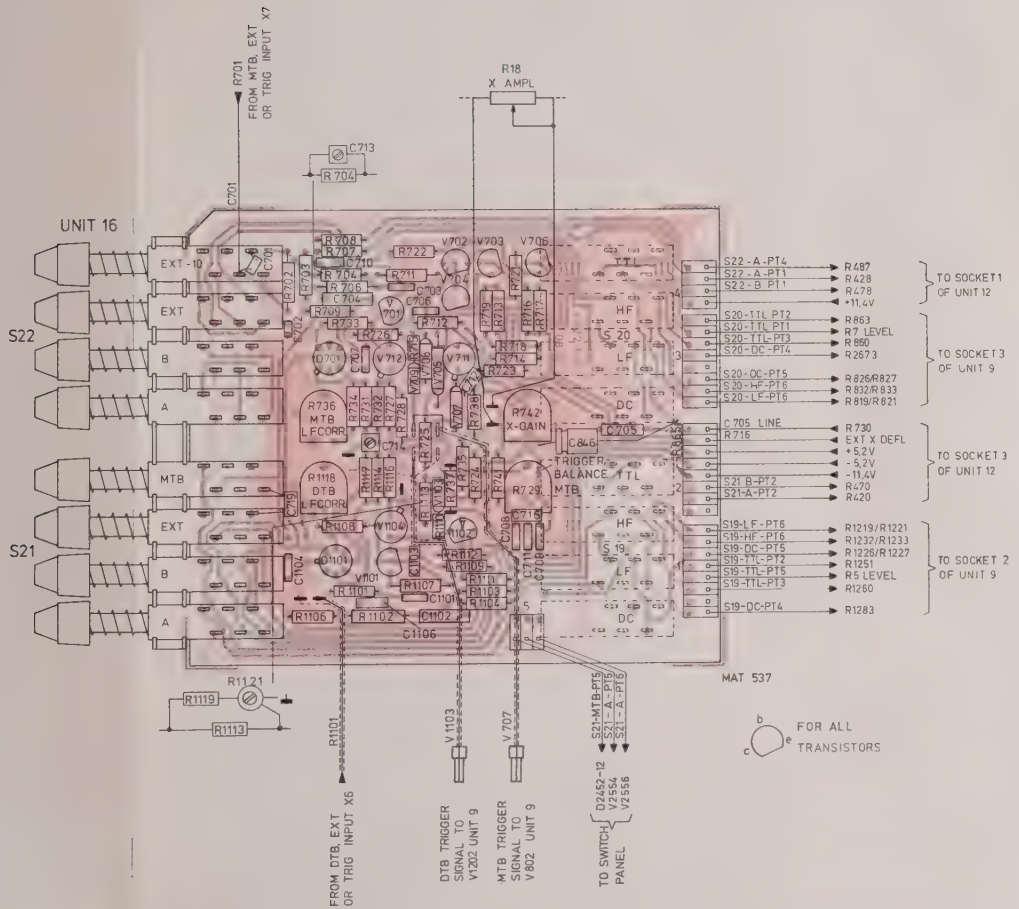


Fig. 12.8. Z-amplifier (UNIT 11)



Fig. 12.9. Intermediate amplifier (UNIT 12)





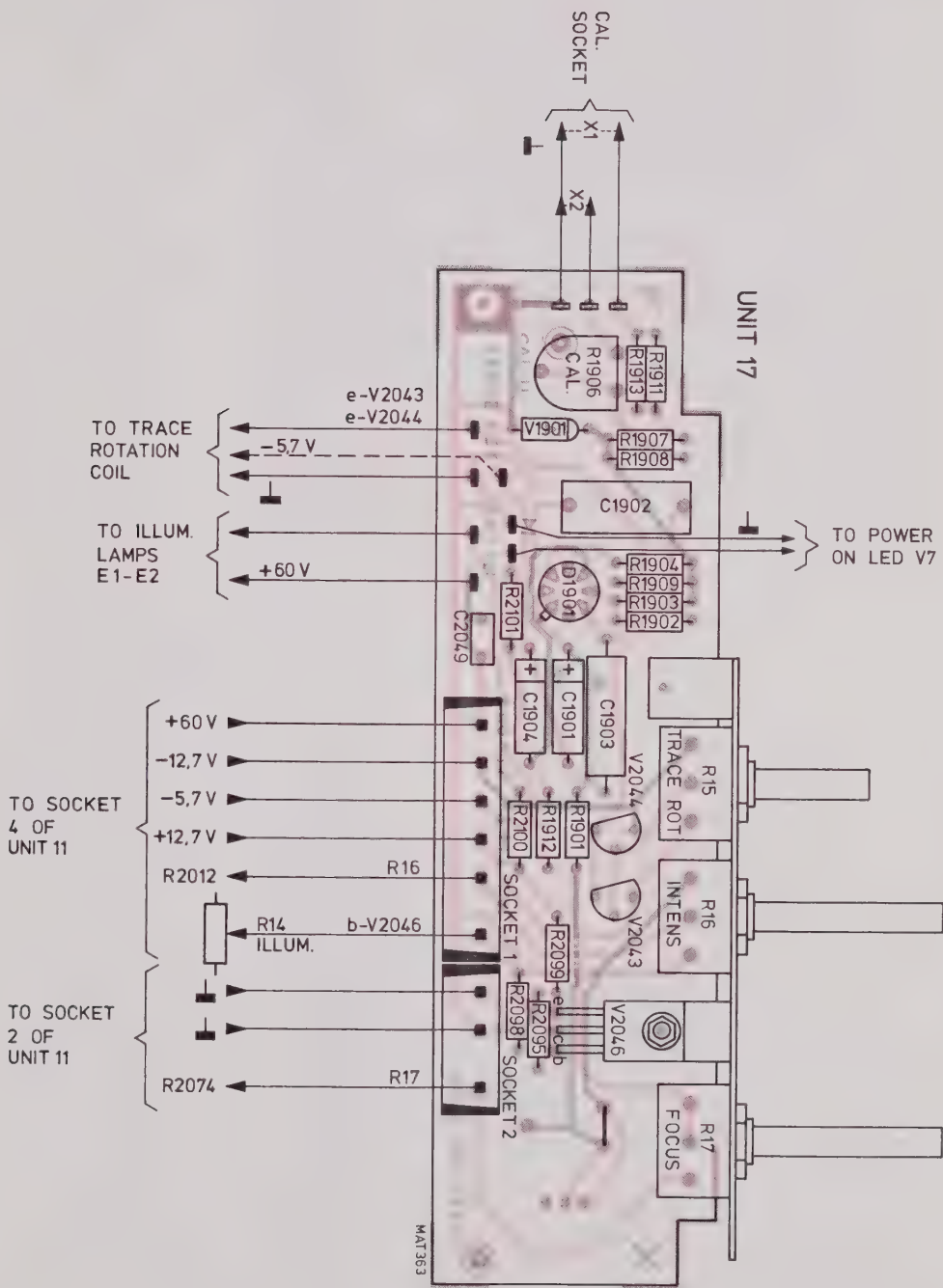


Fig. 12.12. Calibration generator unit (UNIT 17)

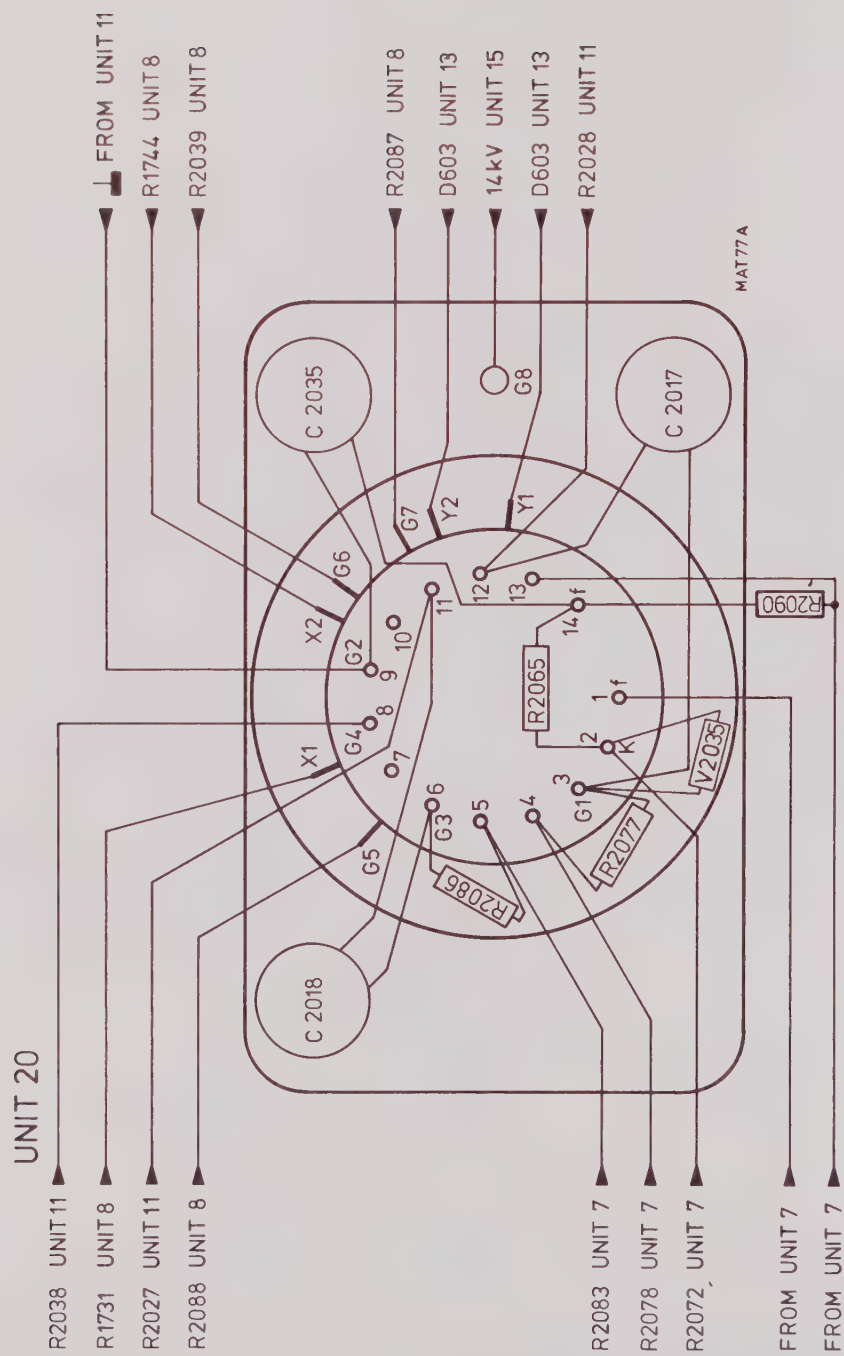


Fig. 12.13. C.R.T. unit (UNIT 20)

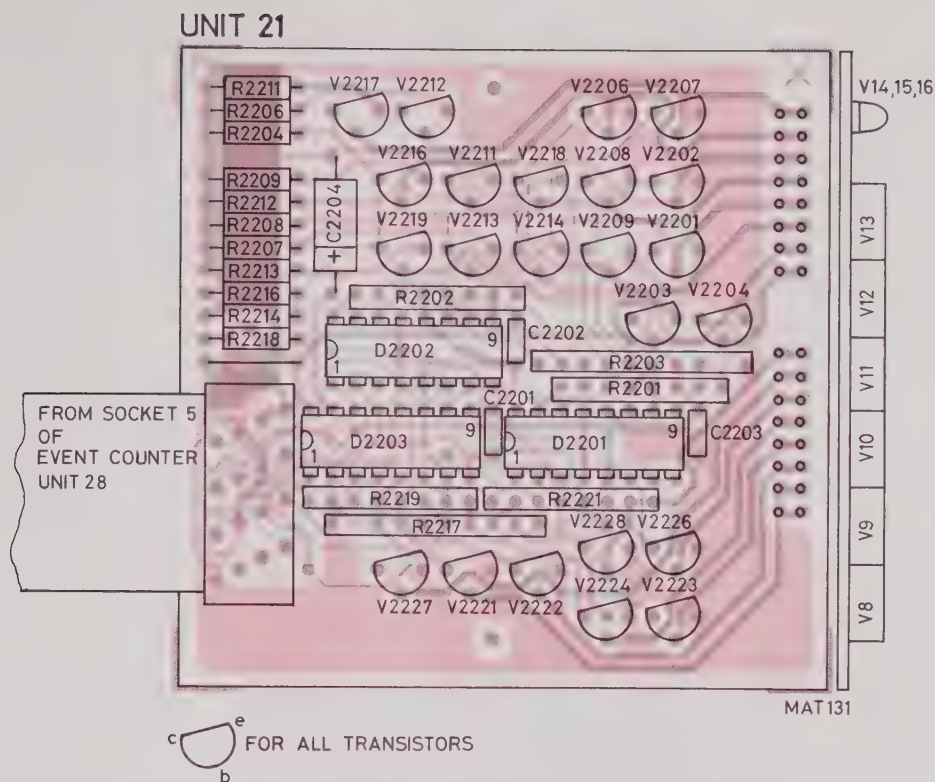


Fig. 12.14. Display unit (UNIT 21)

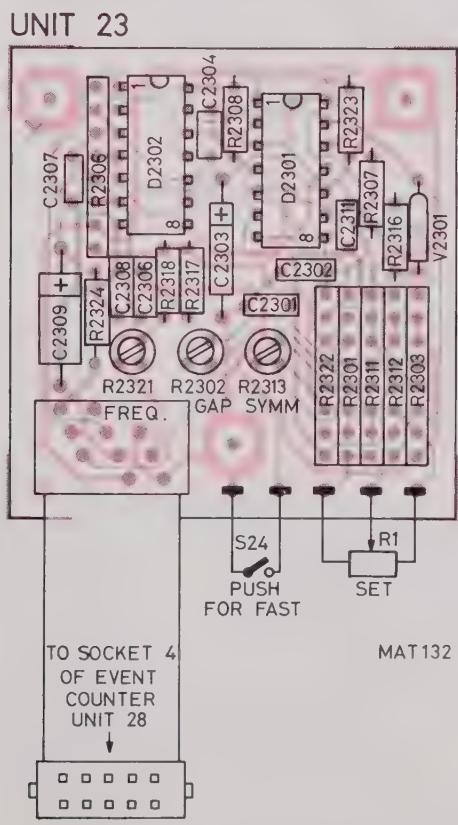


Fig. 12.15. V.C.O. unit (UNIT 23)

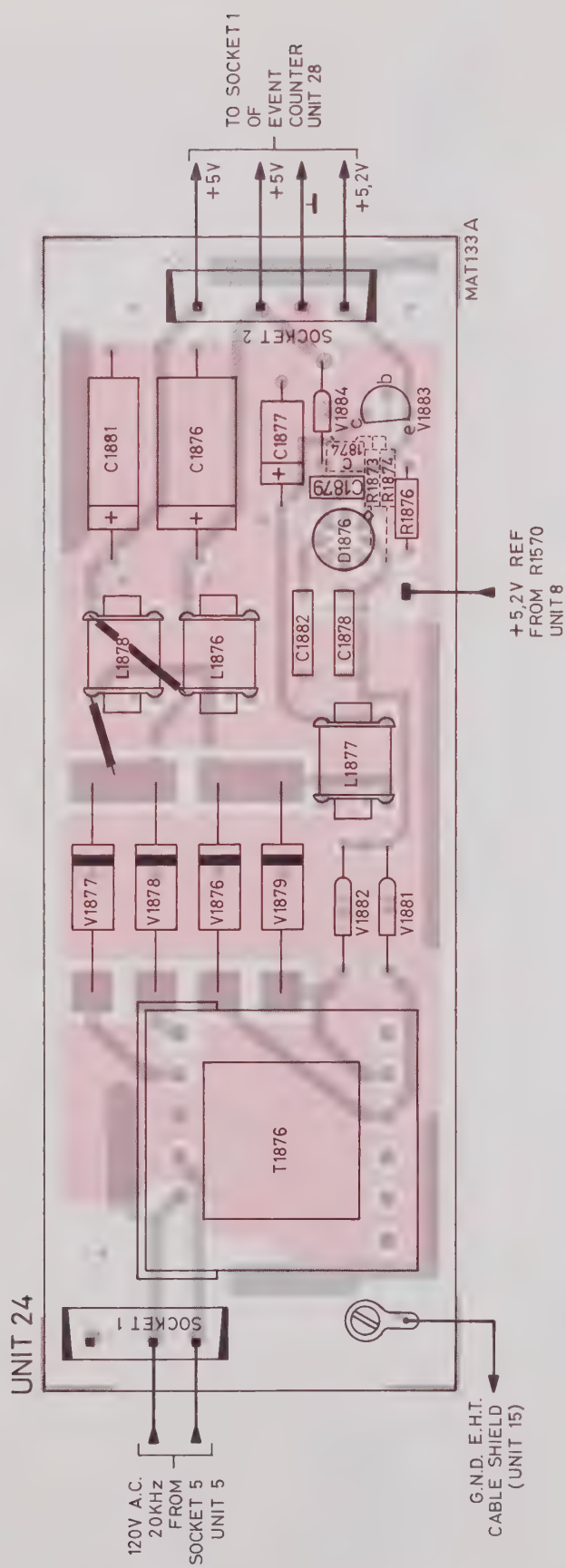


Fig. 12.16. Additional power supply (UNIT 24)

UNIT 27

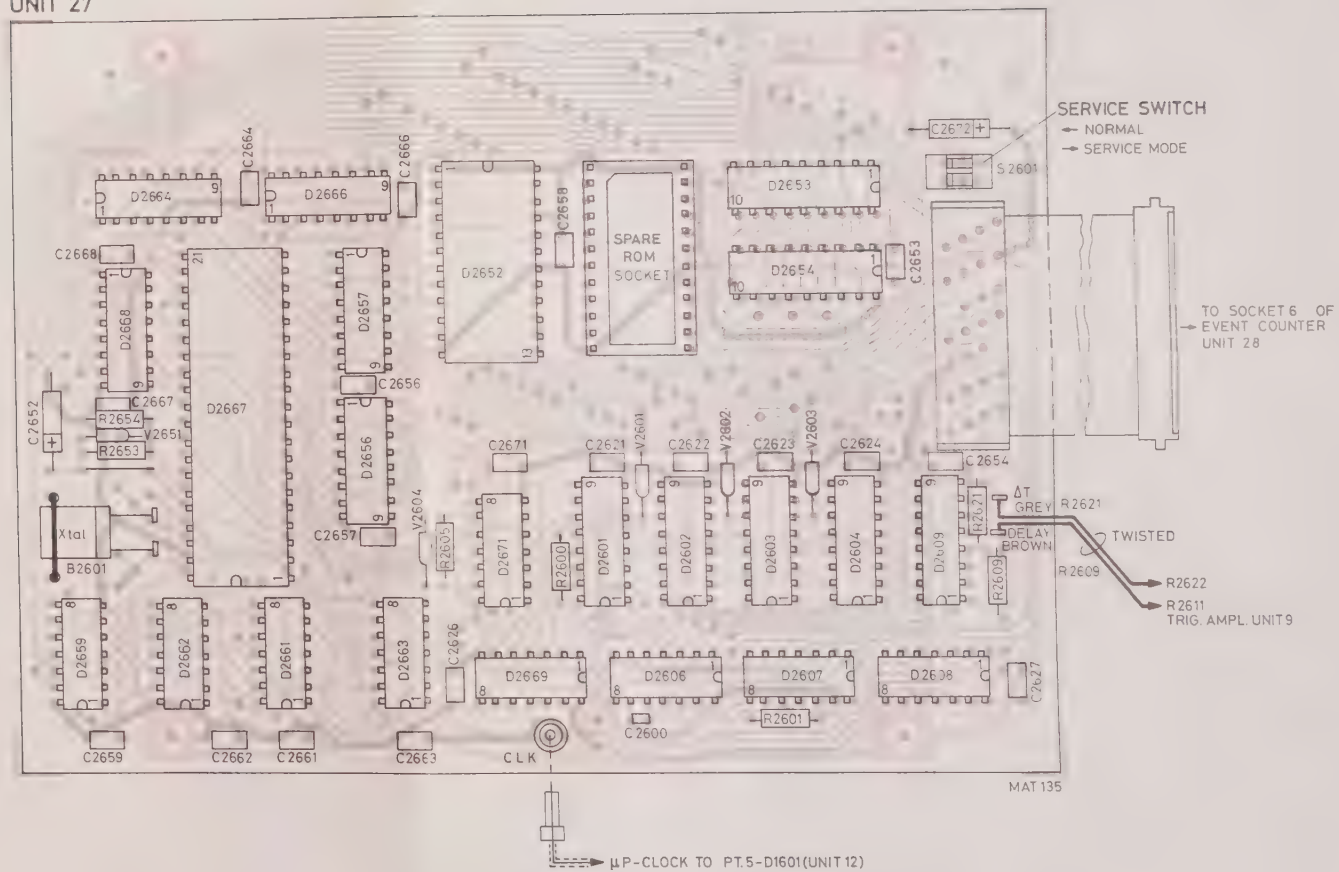


Fig. 12.18. Microprocessor unit (UNIT 27)

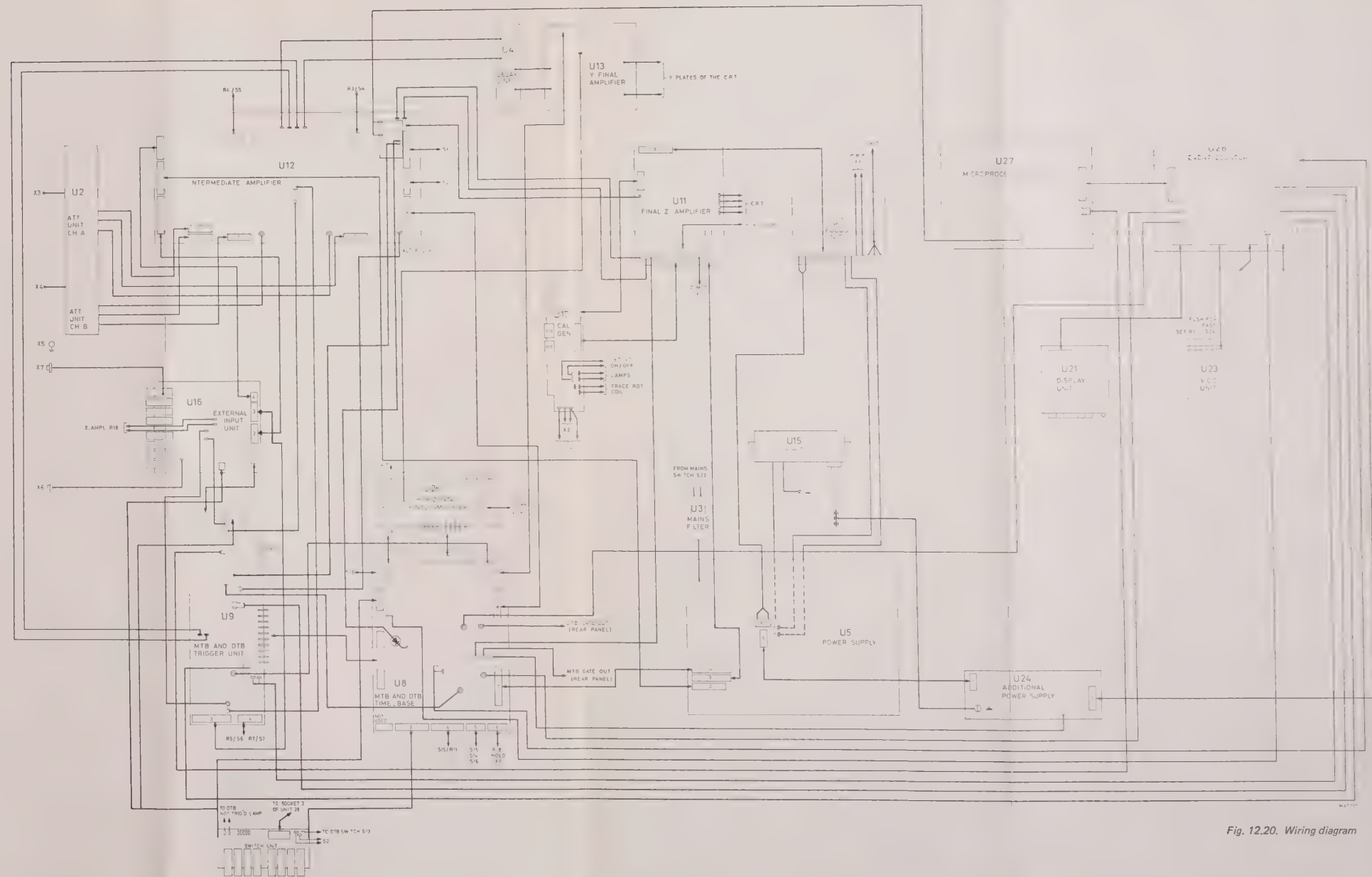
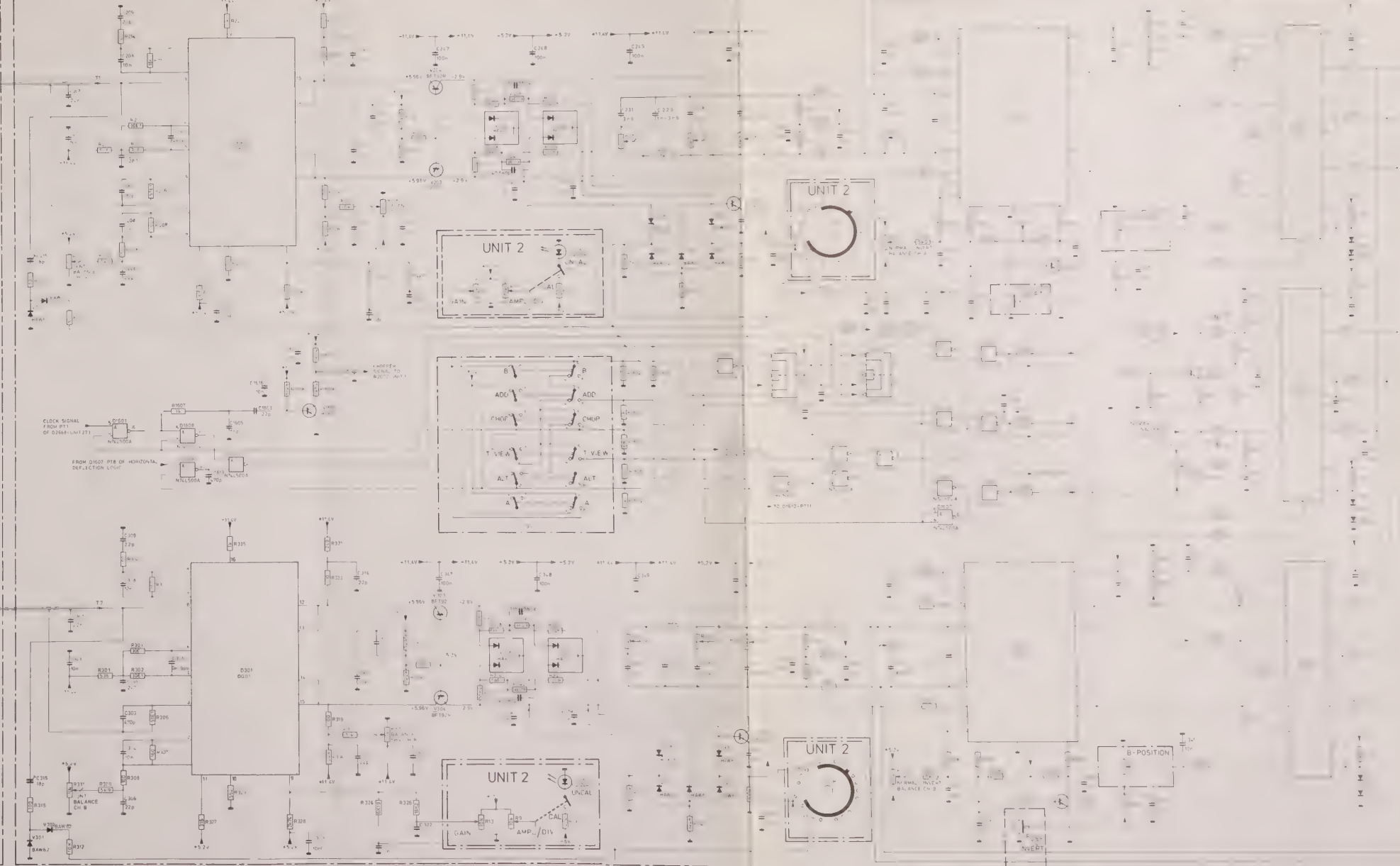
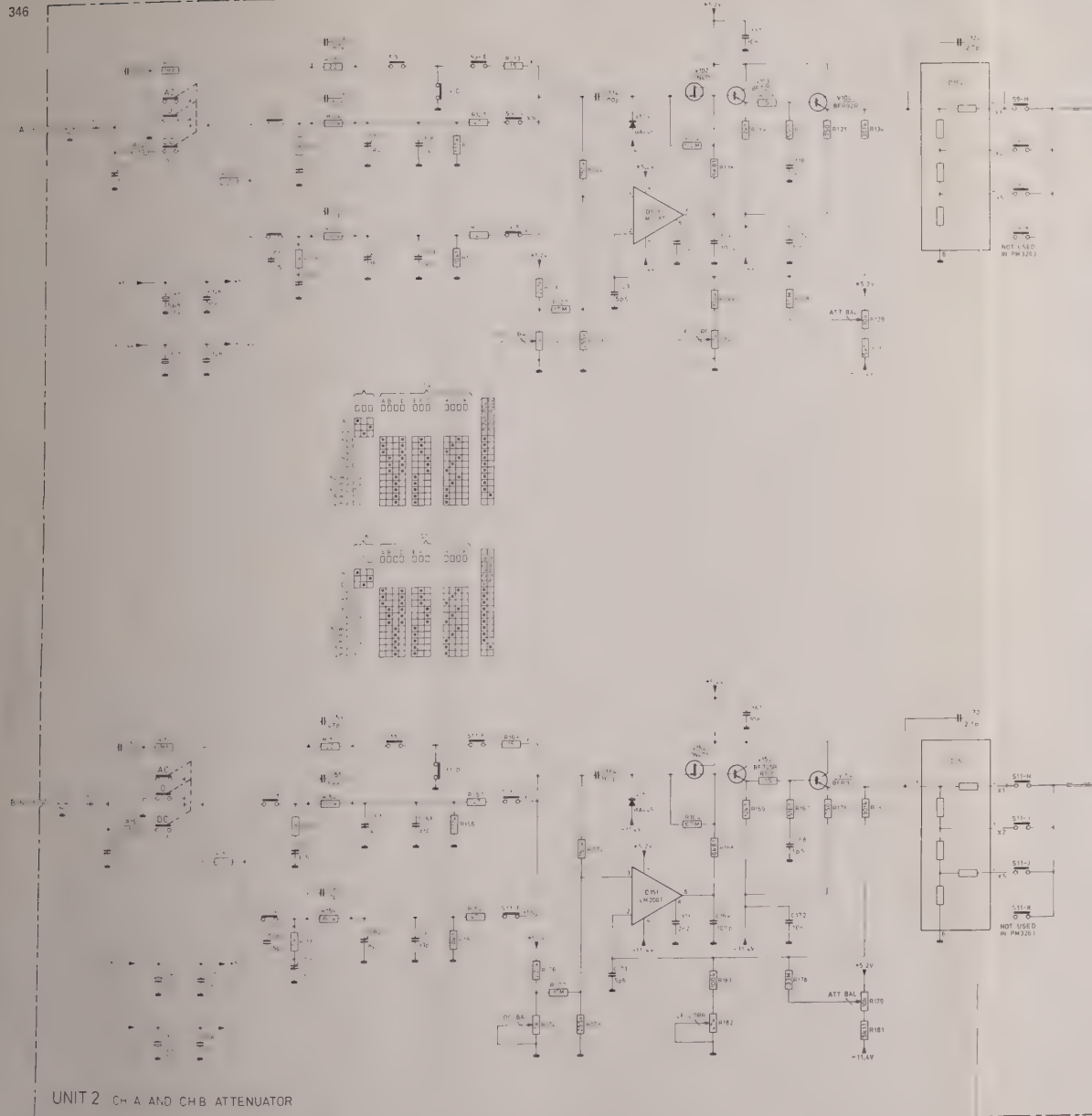
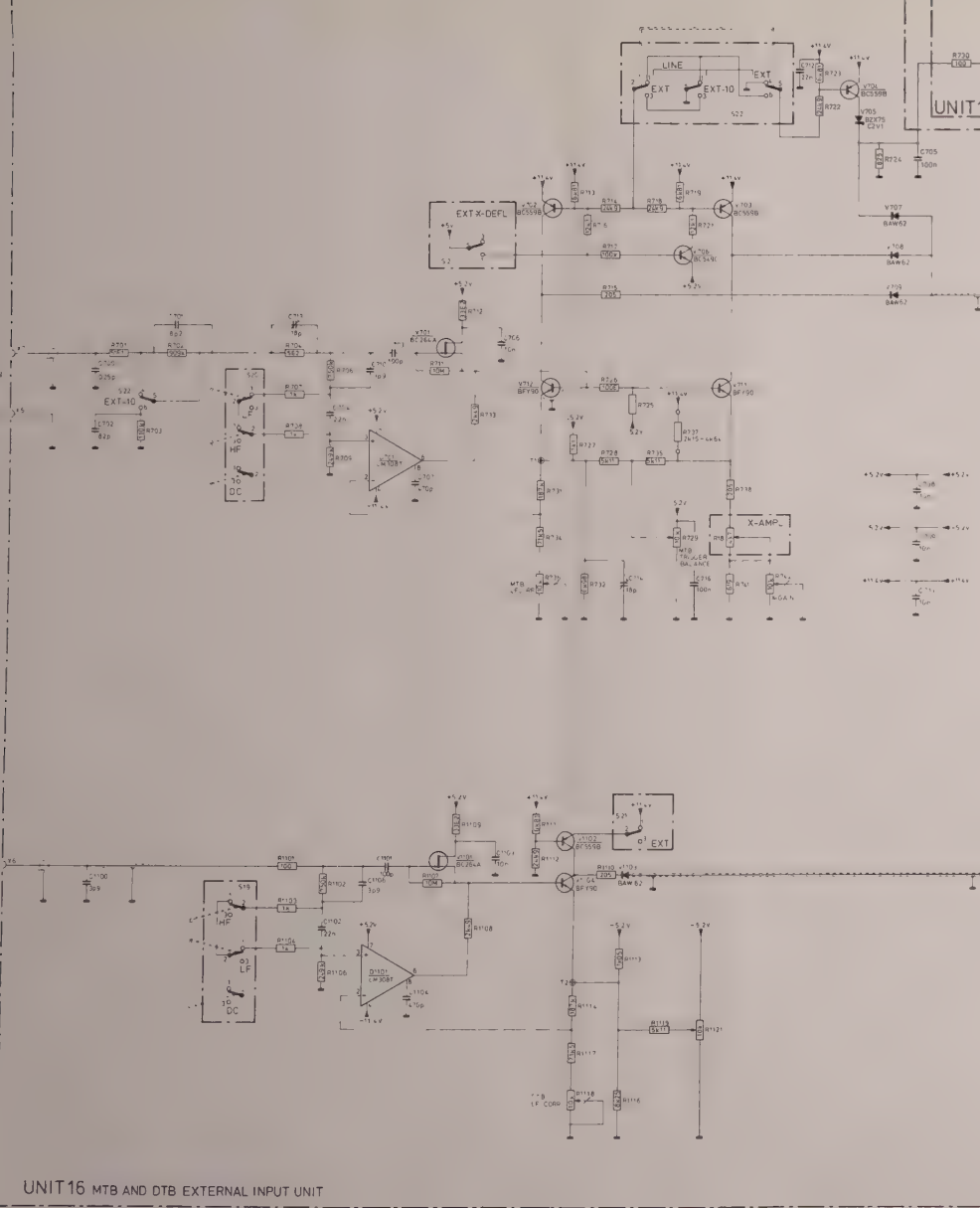


Fig. 12.20. Wiring diagram

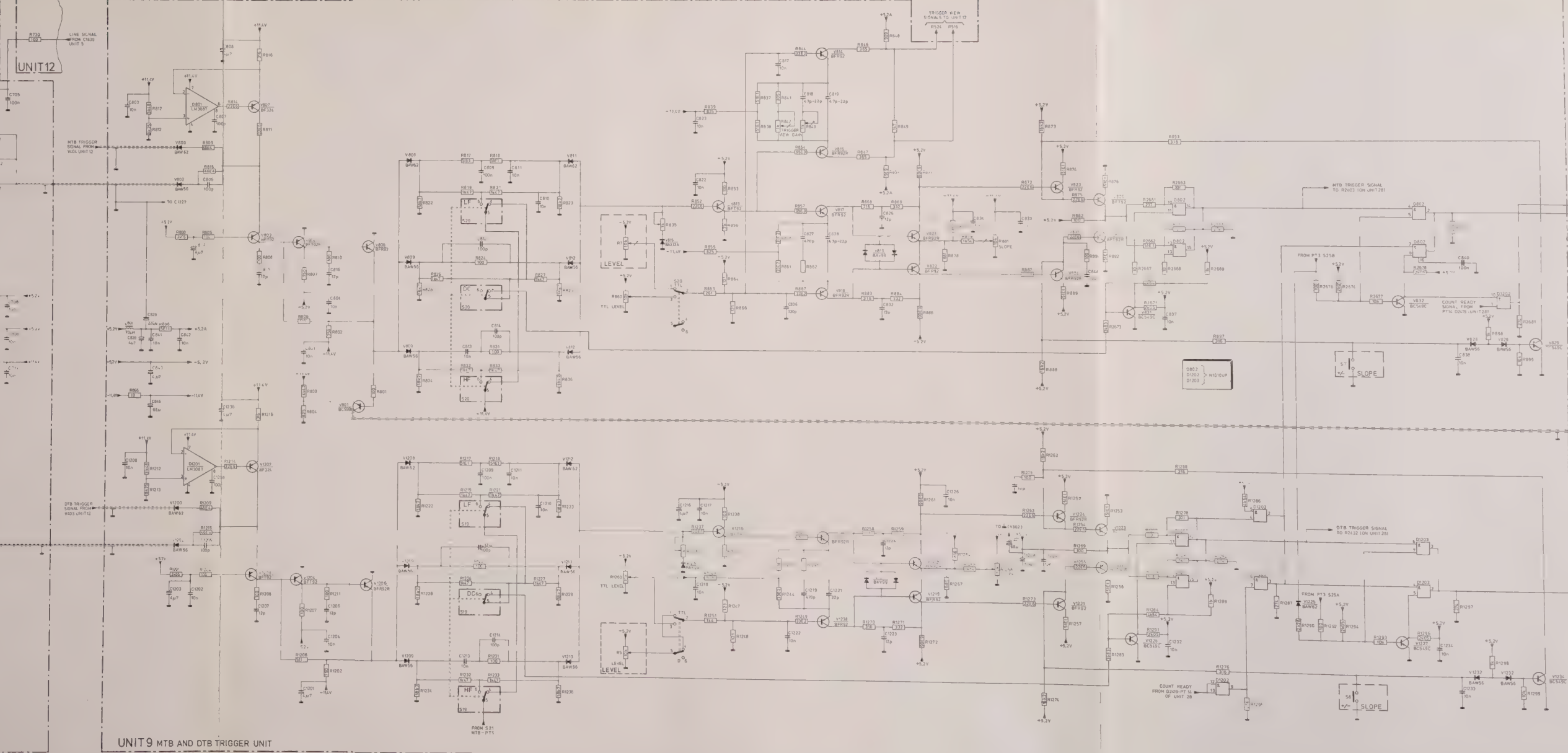


EXTERNAL
TO EXT-10
MEASURING
EARTH
SOCKET

EXTERNAL
TRIGGER
INPUT



UNIT 16 MTB AND DTB EXTERNAL INPUT UNIT



UNIT 9 MTB AND DTB TRIGGER UNIT

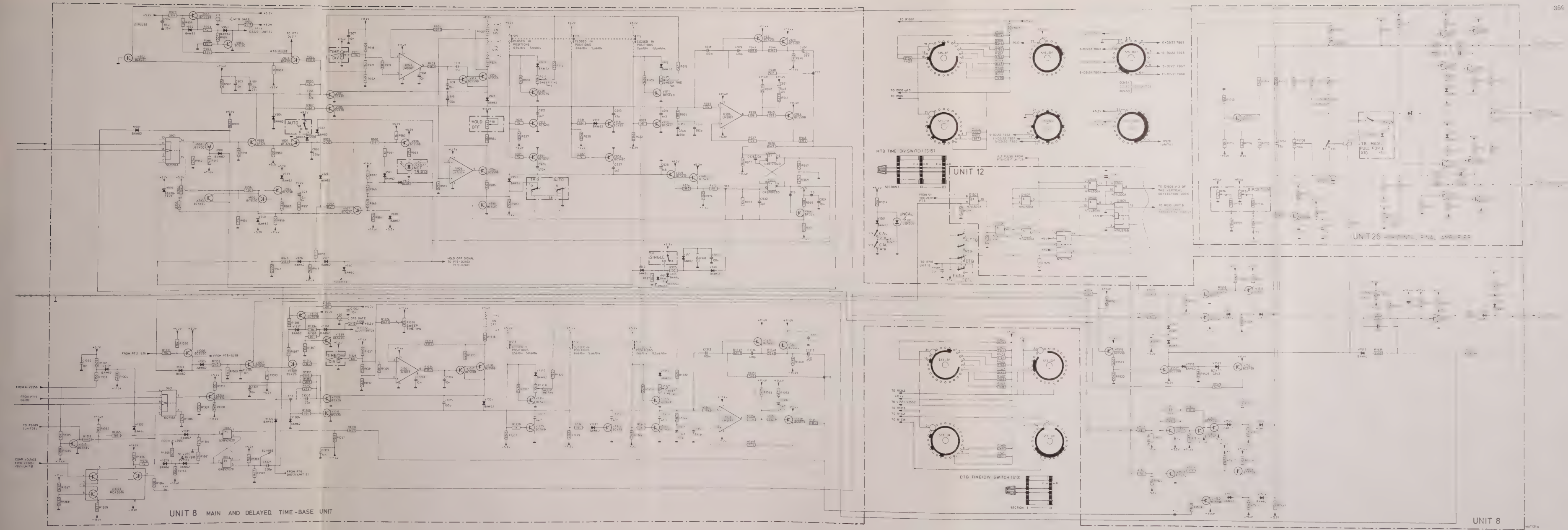
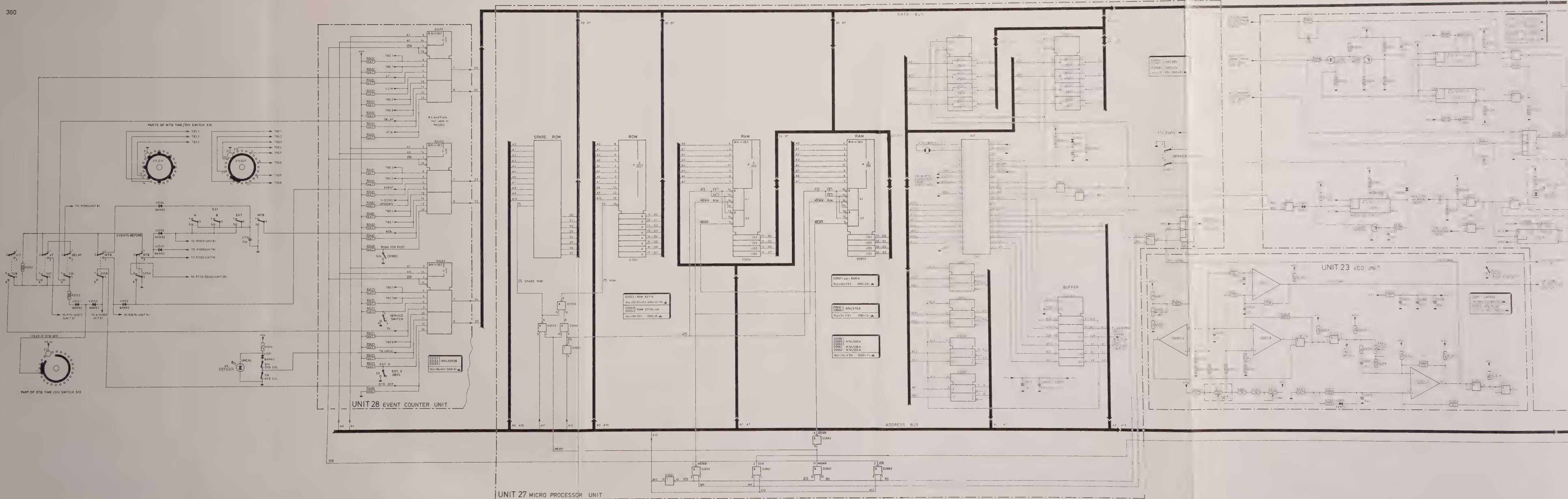


Fig. 12.22. Circuit diagram of the main and delayed time-base



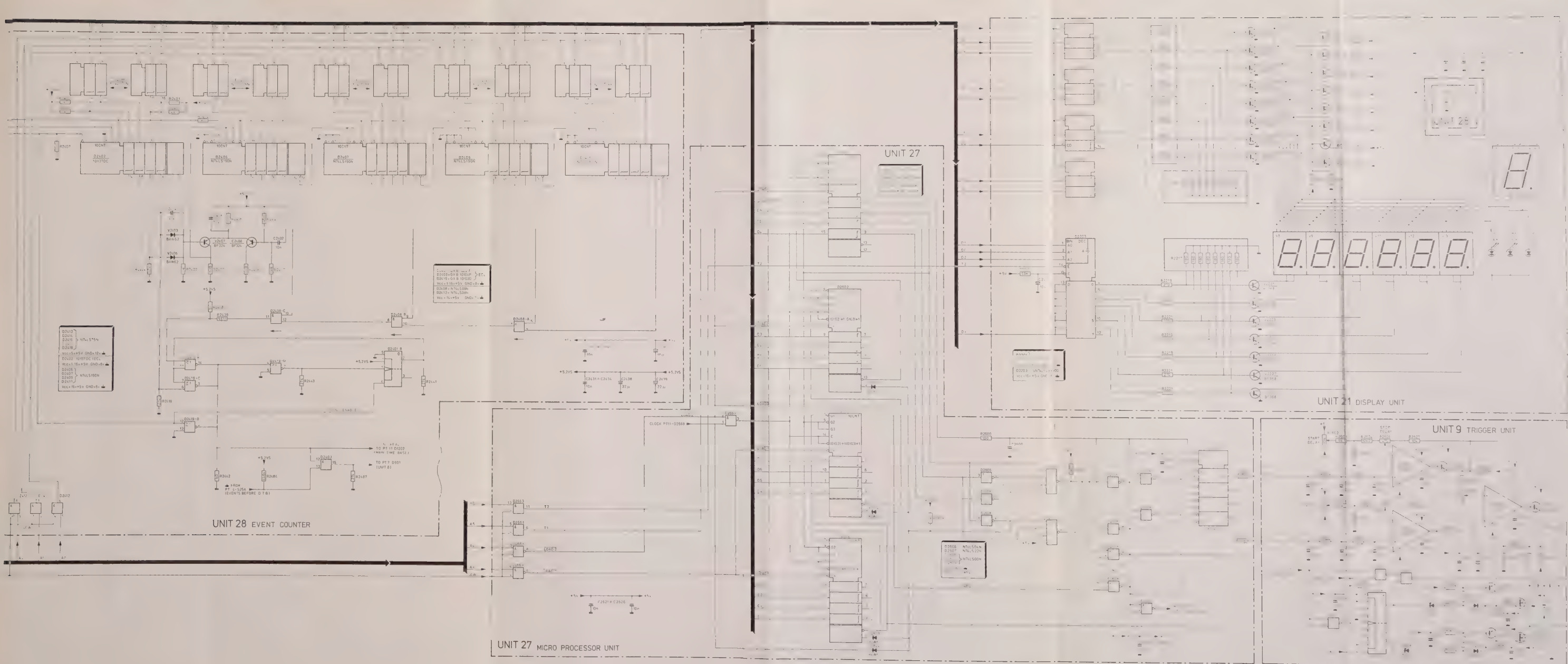
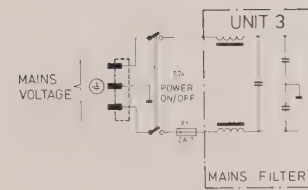


Fig. 12.23. Circuit diagram microprocessor and logic circuits



UNIT 17

UNIT 5 POWER SUPPLY

UNIT 15 E.H.T. UNIT

UNIT 24 ADDITIONAL POWER SUPPLY

UNIT 12 INTERMEDIATE AMPLIFIER UNIT

Fig. 12.24. Circuit diagram of power supply, Z-amplifier and C.R.T. circuit

13. VOLTAGE WAVEFORMS IN THE INSTRUMENT

13.1. INTRODUCTION

The waveforms given in this chapter are typical values and represent the values for an average instrument. So the values measured in your unit under test can differ slightly from the values given in this manual. The waveforms are listed in 3 chapters: vertical deflection (chapter 13.2.), horizontal deflection (chapter 13.3.) and CRT display section (chapter 13.4.). If for instance a fault is expected in the horizontal display section check the waveforms in chapter 13.2. The test must be started with the first waveform in the chapter.

The waveforms and test patterns that can be measured in the digital delay section of the instrument are given in chapter 9.12. of this manual.

Many of the test points are marked on the units and are provided with attachment points for a measuring probe.

The required test equipment for measuring the waveforms is an oscilloscope with a bandwidth of 50 MHz or more (e.g. Philips PM3240) with a suitable 10:1 attenuator probe. The input square wave signal for the instrument under test can be obtained from a function generator (e.g. Philips PM5127).

The instrument under test has the following settings of the controls (unless otherwise indicated):

- Push the Y-position controls to the normal (non inverted) position.
- Put the signal coupling switches of channel A and B in the DC-position.
- Depress push-button A of the vertical display mode selector.
- Put the channel A and B AMPL/DIV switch in the 1V/DIV position and their vernier controls to CAL.
- Depress push-button MAIN TB of the horizontal display mode selector.
- Push the TB MAGN control to the X1-position.
- Depress push-button AUTO of the trigger mode selector.
- Put the main time-base TIME/DIV switch in the 20 μ s/DIV position and its vernier control to CAL.
- Put the delayed time-base TIME/DIV switch in the OFF-position and its vernier control to CAL.
- Depress push-button DC of the main and delayed time-base trigger coupling controls.
- Depress push-button A of the main and delayed time-base trigger source controls.
- Apply a square-wave voltage of 6Vp.p/10 kHz to the input sockets of channel A and B.
- Put the signal in the middle of the screen by means of the channel A and B position controls.
- Put the variable HOLD OFF control in the CAL position.

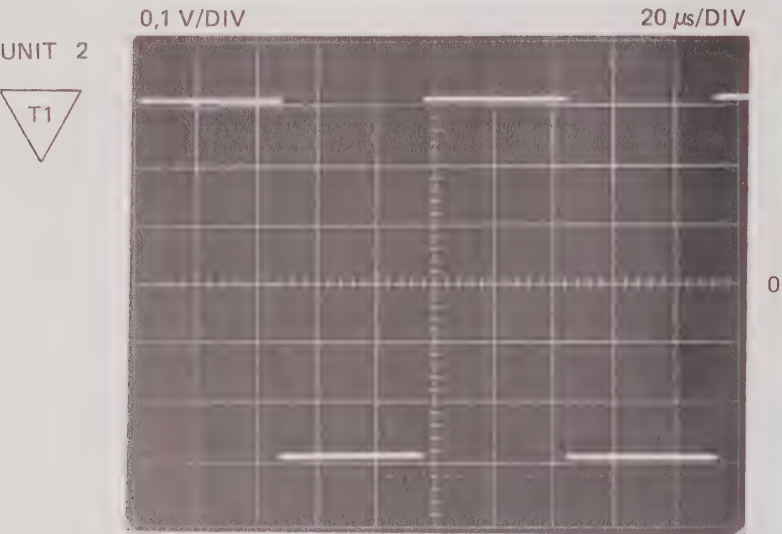
The measuring oscilloscope has the following settings of the controls (unless otherwise indicated):

- The waveforms are measured on channel A; the required AMPL/DIV position is indicated.
- The vertical position of the main time base line without input signal is indicated in the waveform diagram with "O".
- The instrument is triggered on the signal available on test point T1 on unit 2 (attenuator unit). This signal can be applied to channel B with the AMPL/DIV switch in the 0,1V/DIV position.
- Only the main time-base is used and the required TIME/DIV position is indicated.
- The signal coupling control occupies the AC position.
- The main time-base trigger coupling control occupies the DC position.

The units on which voltage waveforms can be measured are:

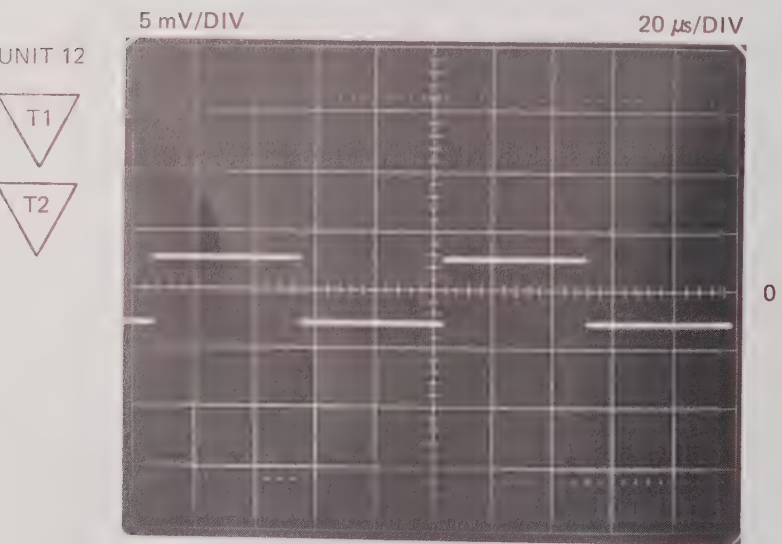
unit 2	= attenuator unit
unit 12	= intermediate amplifier
unit 13	= final vertical amplifier
unit 9	= trigger amplifier
unit 8	= time-base unit
unit 26	= final horizontal amplifier
unit 11	= Z-amplifier

13.2. VERTICAL DEFLECTION



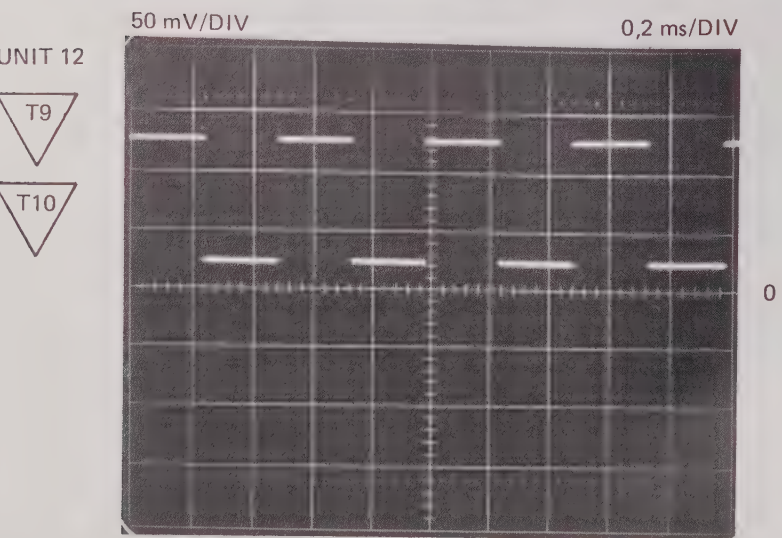
measuring oscilloscope:

- DC signal coupling.



measuring oscilloscope:

- DC signal coupling.



measuring oscilloscope:

- triggering on signal on test point T9/T10 of unit 12.
- DC signal coupling.

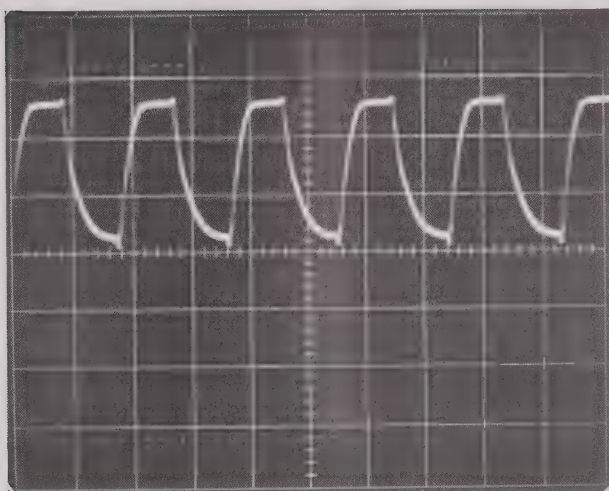
oscilloscope under test:

- no input signal.
- push-button ALT of vertical display mode depressed.

UNIT 12



50 mV/DIV

0,5 μ s/DIV

0

measuring oscilloscope:

- triggering on signal on test point T9/10 of unit 12.
- DC signal coupling.

oscilloscope under test:

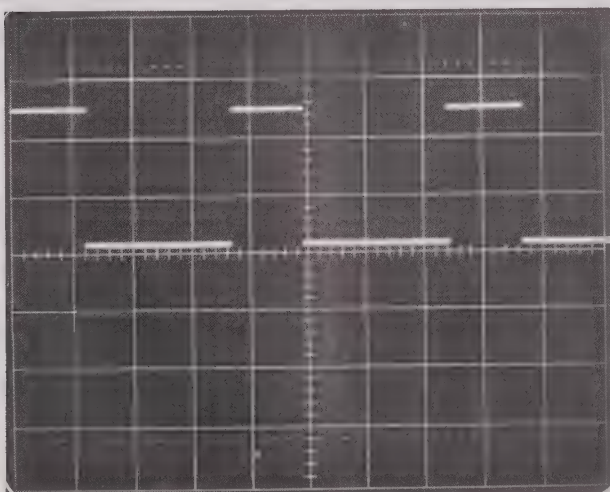
- no input signal.
- push-button CHOP of vertical display mode depressed.

UNIT 12



50 mV/DIV

0,2 ms/DIV



0

measuring oscilloscope:

- triggering on signal on test point T11 of unit 12.
- DC signal coupling.

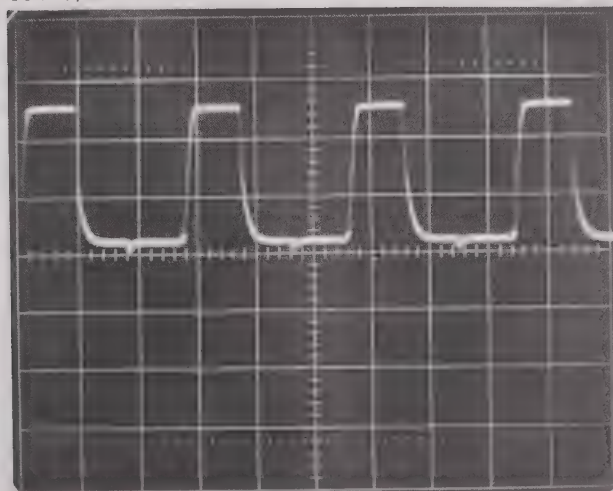
oscilloscope under test:

- no input signal.
- push-buttons ALT and TRIG VIEW of vertical display mode simultaneously depressed.

UNIT 12



50 mV/DIV

0,5 μ s/DIV

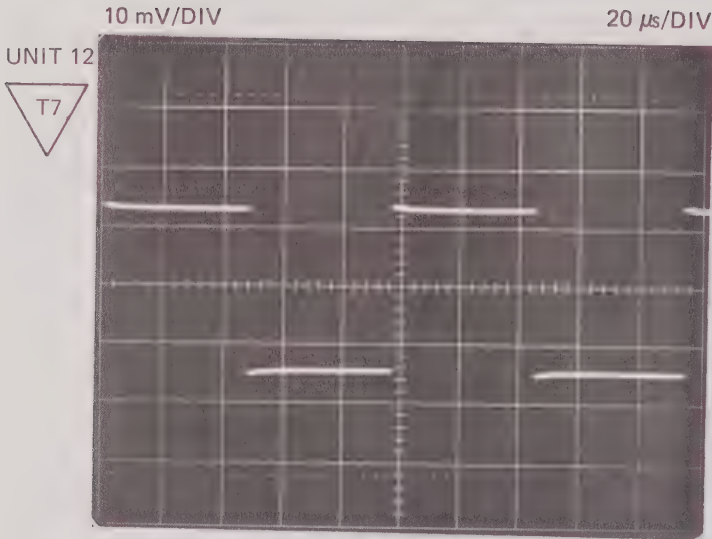
0

measuring oscilloscope:

- triggering on signal on test point T11 of unit 12.
- DC signal coupling.

oscilloscope under test:

- no input signal.
- push-buttons CHOP and TRIG VIEW of vertical display mode simultaneously depressed.

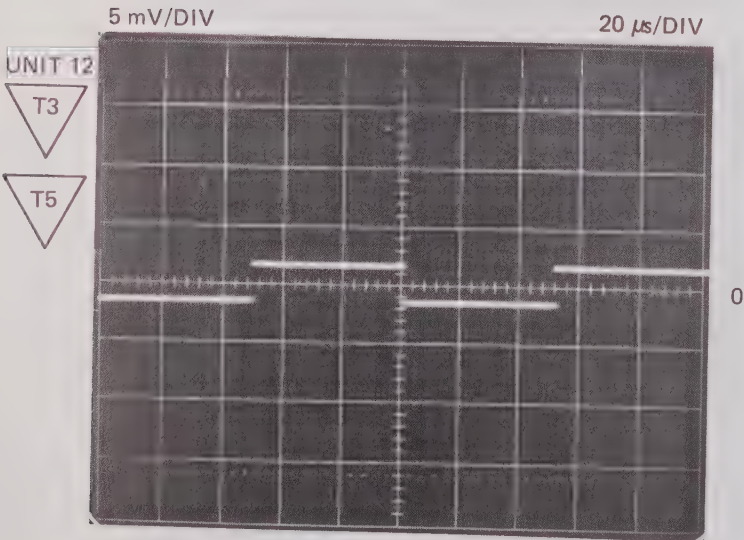
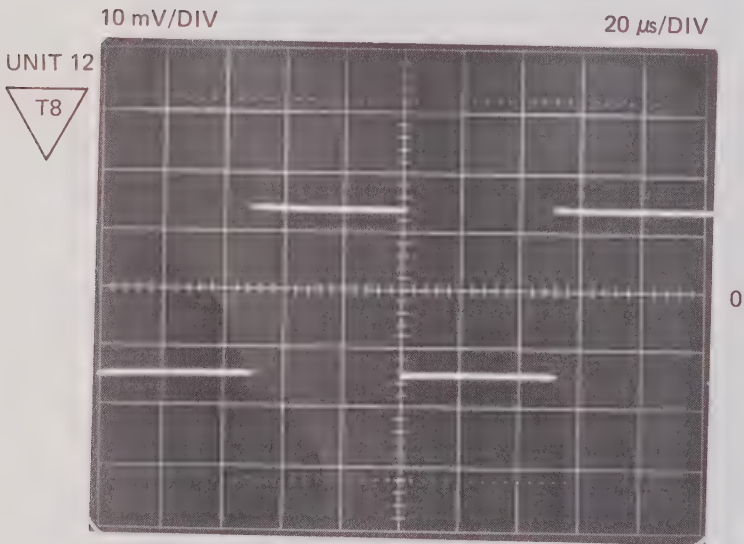


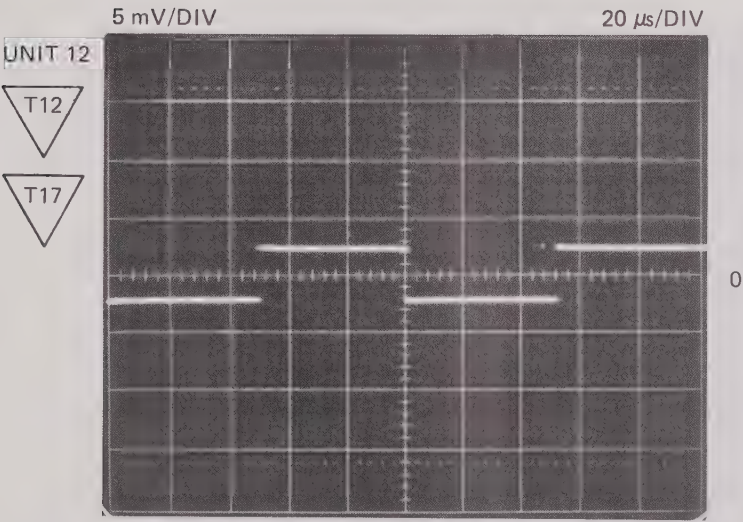
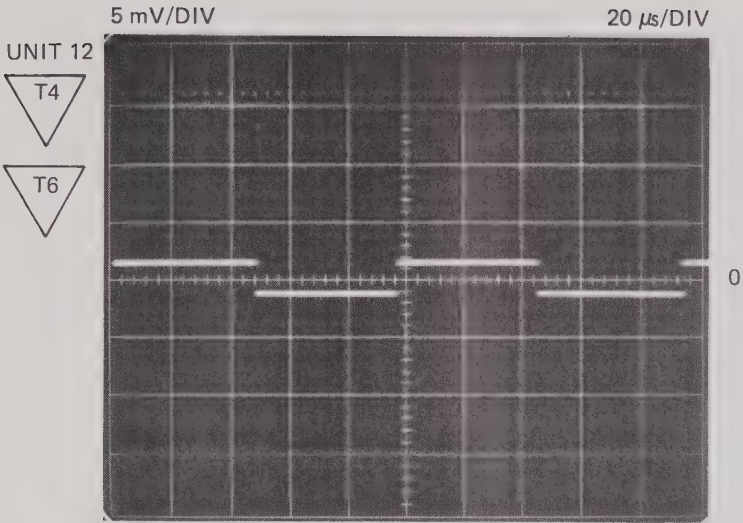
measuring oscilloscope:

- other settings as indicated in introduction.

oscilloscope under test:

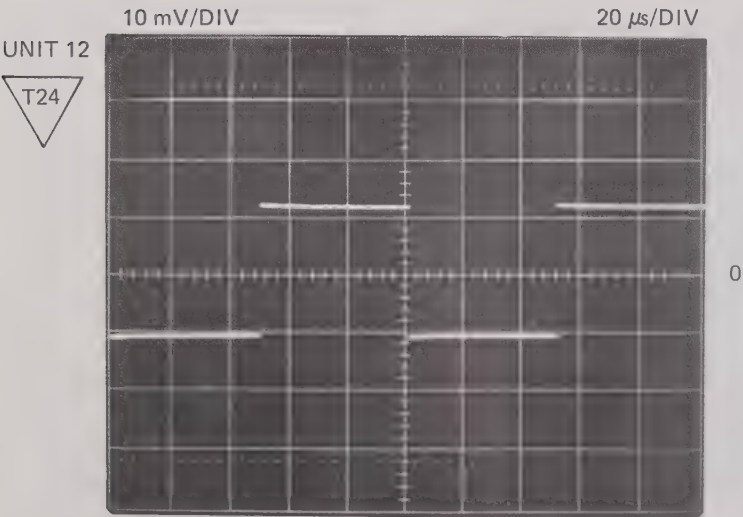
- settings as indicated in introduction.

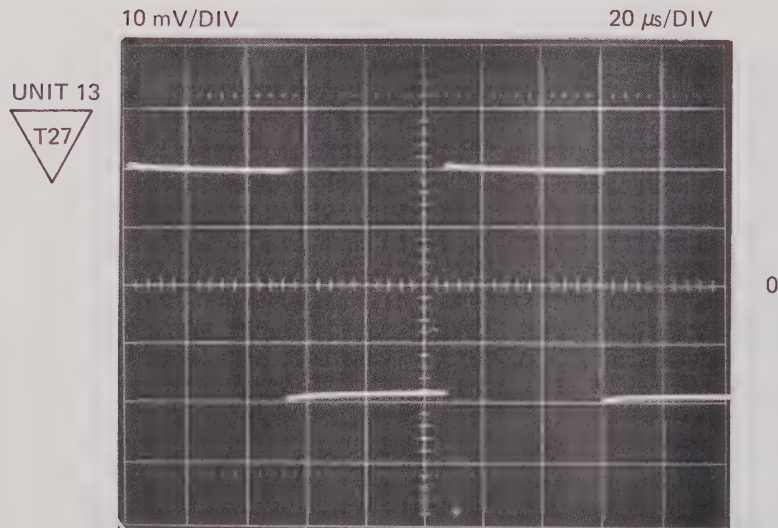
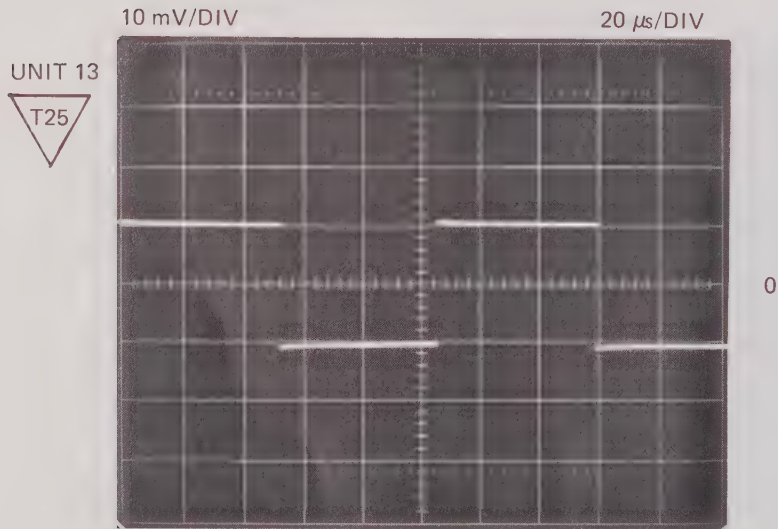
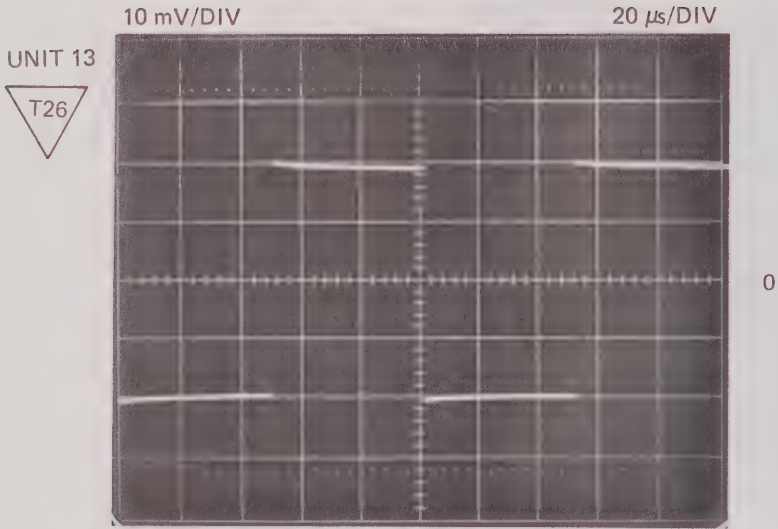




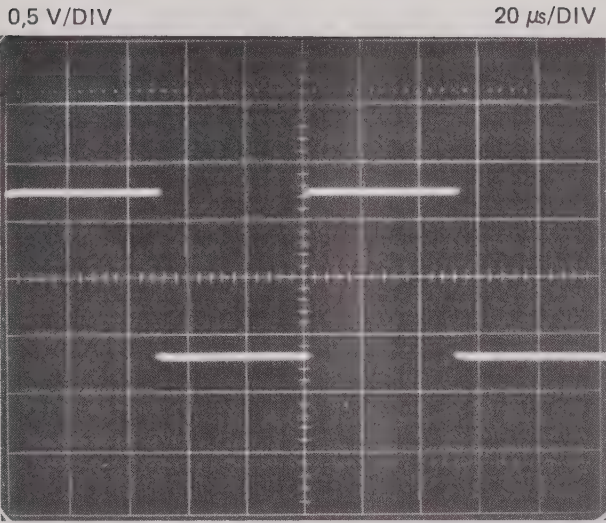
oscilloscope under test:

- depress push-button A or B on the main and delayed time base trigger source selector.





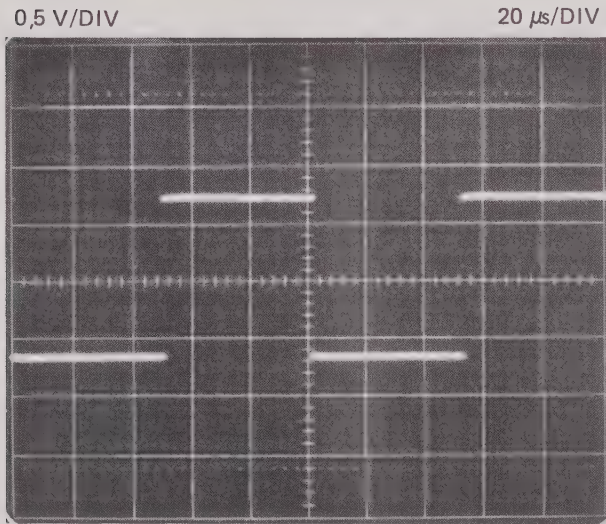
UNIT 13
T28



oscilloscope under test:

- Voltage must be measured on side connection of CRT. Do this very careful: if the side pins are bent, the CRT is likely to develop a gas leak.

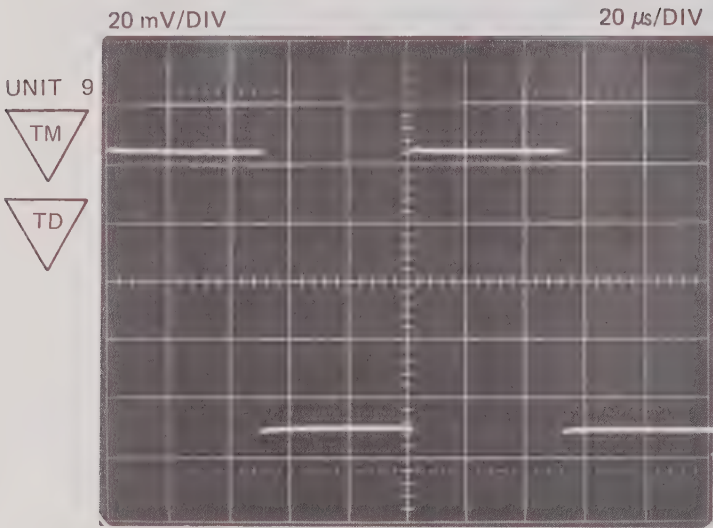
UNIT 13
T29



oscilloscope under test:

- Voltage must be measured on side connection of CRT. Do this very careful: if the side pins are bent, the CRT is likely to develop a gas leak.

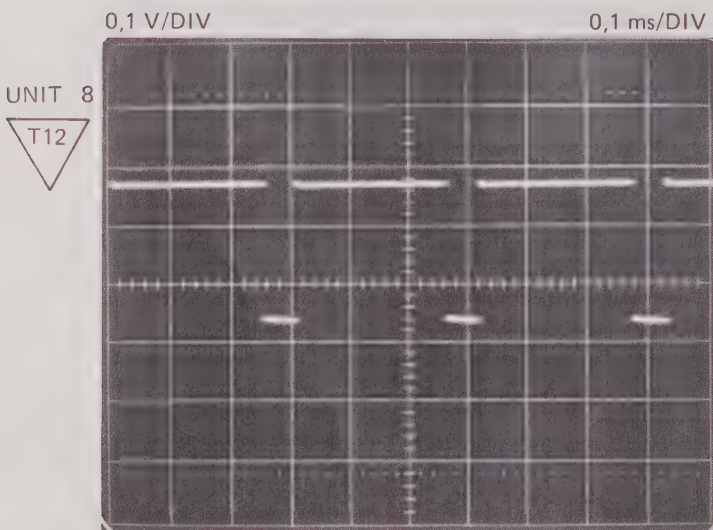
13.3. HORIZONTAL DEFLECTION



0

oscilloscope under test:

- Put the main and delayed time-base LEVEL controls in their mid-position.



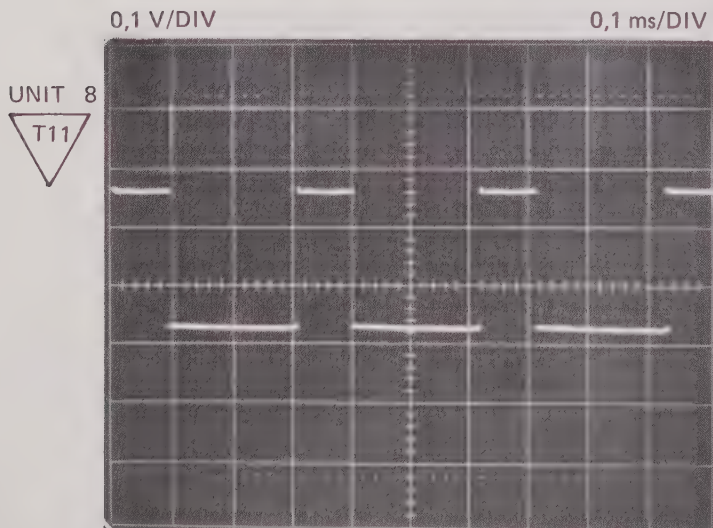
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measuring oscilloscope:

- Triggering on signal on test point T12 of unit 8.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- Depress push-button MAIN TB of delayed time-base trigger source switch.
- Put the delayed time-base TIME/DIV switch in the 5 μ s/DIV position.



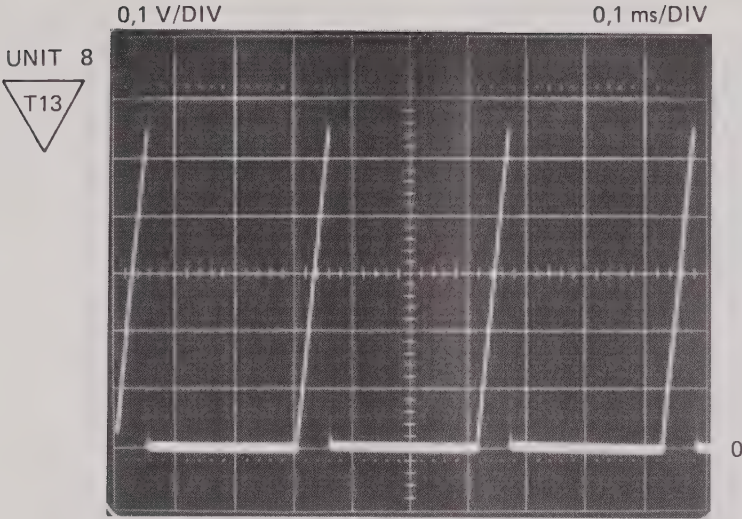
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measuring oscilloscope:

- Triggering on signal on test point T11 of unit 8.
- DC signal coupling.

oscilloscope under test:

- No input signal.

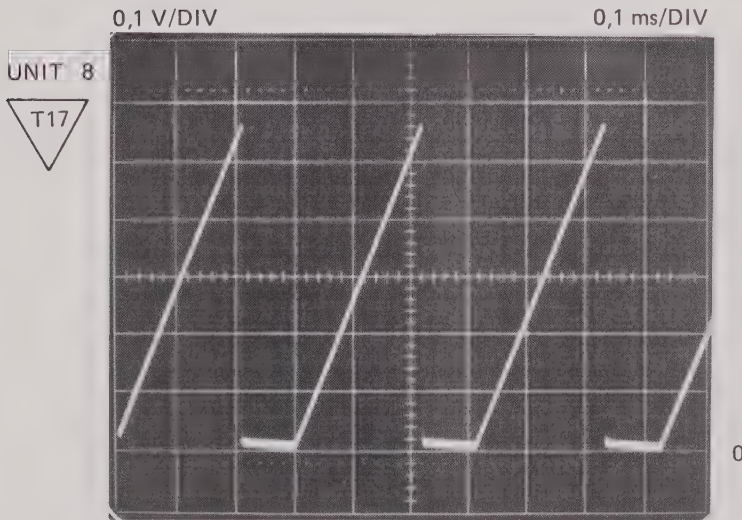


measuring oscilloscope:

- Triggering on signal on test point T13 of unit 8.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- Put the delayed time-base TIME/DIV switch in the $5\mu\text{s}/\text{DIV}$ position.

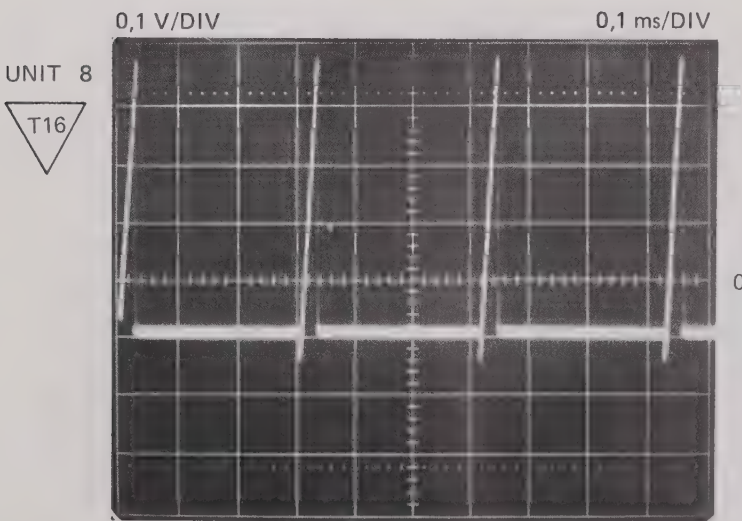


measuring oscilloscope:

- Triggering on signal on test point T17 of unit 8.
- DC signal coupling.

oscilloscope under test:

- No input signal.

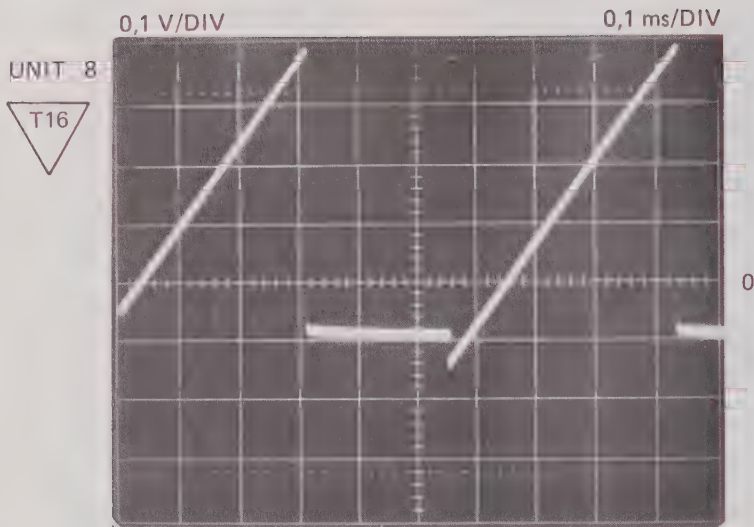


measuring oscilloscope:

- Triggering on signal on test point T16 of unit 8.
- DC signal coupling.

oscilloscope under test:

- No input signal.



measuring oscilloscope:

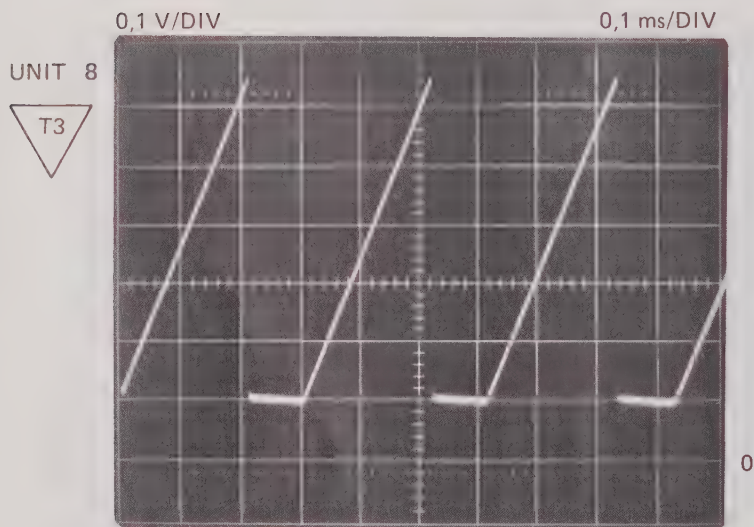
- Triggering on signal on test point T16 of

unit 8.

- DC signal coupling.

oscilloscope under test:

- No input signal.
- HOLD OFF control fully anti-clockwise.



measuring oscilloscope:

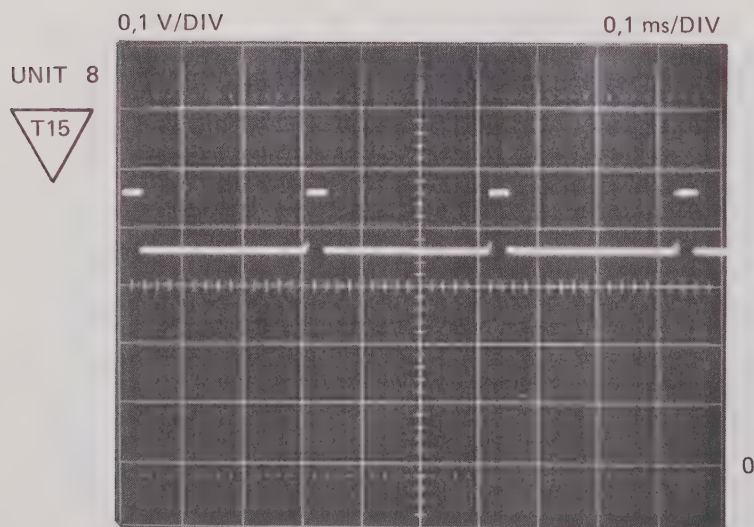
- Triggering on signal on test point T3 of

unit 8.

- DC signal coupling.

oscilloscope under test:

- No input signal.
- Put the HOLD OFF control in the CAL position.



measuring oscilloscope:

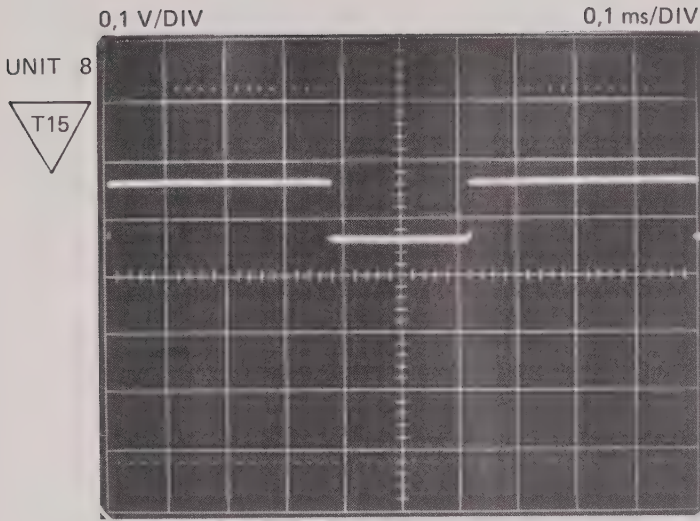
- Triggering on signal on test point T15 of

unit 8.

- DC signal coupling.

oscilloscope under test:

- No input signal.

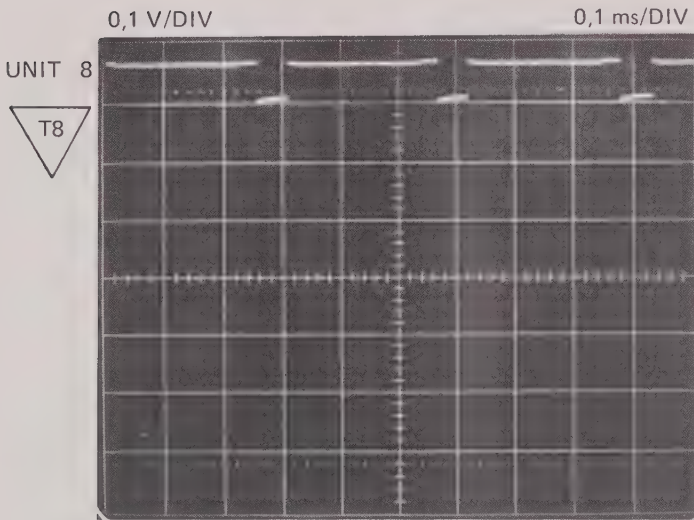
**measuring oscilloscope:**

- Triggering on signal on test point T15 of unit 8.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- HOLD OFF control fully anti-clockwise.

0

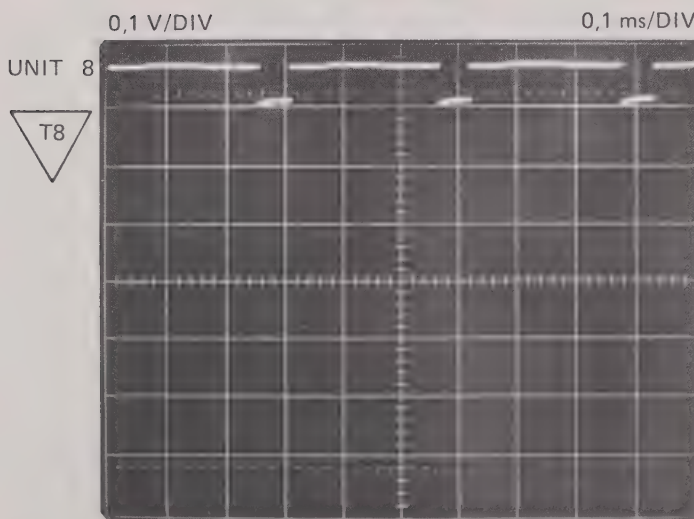
**measuring oscilloscope:**

- Triggering on signal on test point T8 of unit 8.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- Put the HOLD OFF control in the CAL position.
- Put the delayed time-base TIME/DIV switch in the 5 μ s/DIV position.
- Depress push-button MAIN TB of the delayed time-base trigger source selector.
- Adjust the LED-display to 0.0 –6.

0

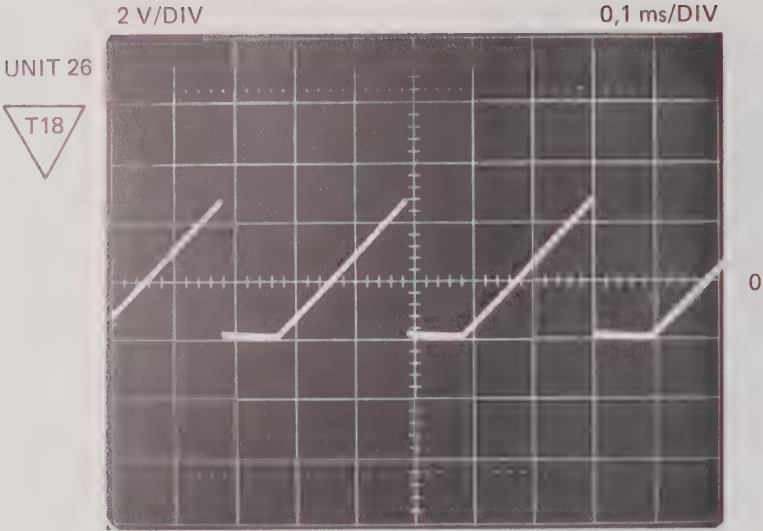
**measuring oscilloscope:**

- Triggering on signal on test point T8 of unit 8.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- Adjust the LED-display to 100.0 –6.

0

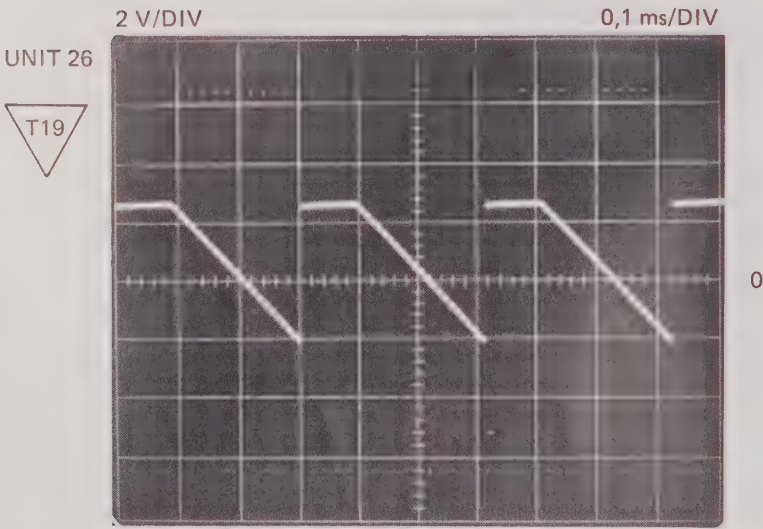


measuring oscilloscope:

- Triggering on signal on test point T18 of unit 26.
- DC signal coupling.

oscilloscope under test:

- No input signal.



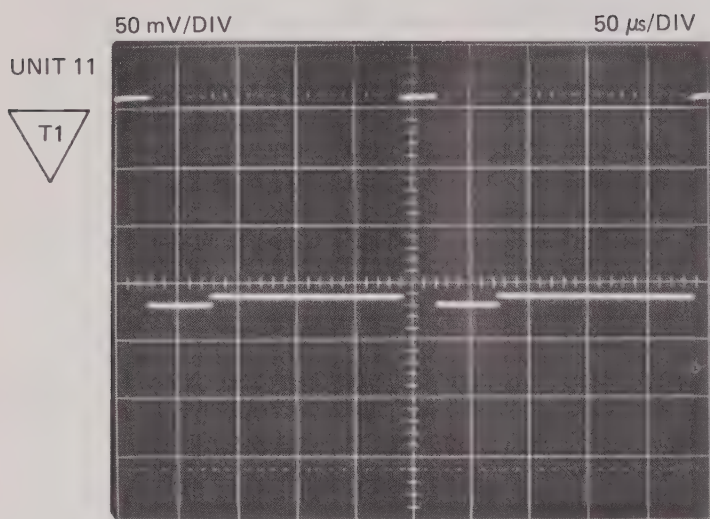
measuring oscilloscope:

- Triggering on signal on test point T19 of unit 26.
- DC signal coupling.

oscilloscope under test:

- No input signal.

13.4. WAVEFORMS IN CRT-DISPLAY SECTION

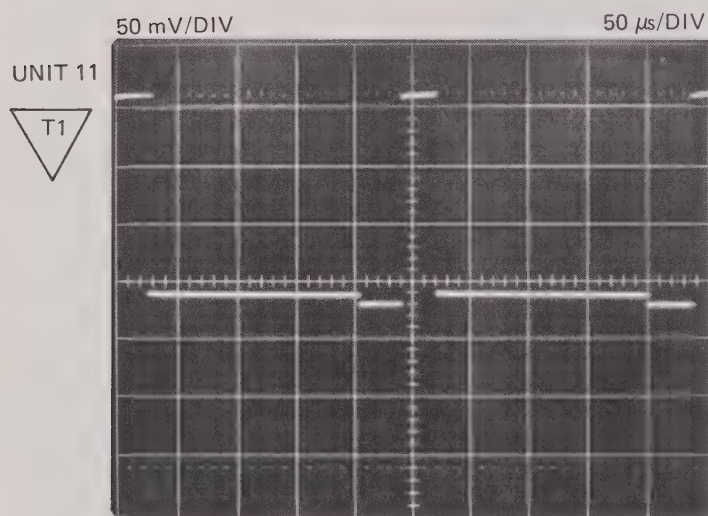


measuring oscilloscope:

- Triggering on signal on test point T1 of unit 11.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- Adjust to minimum intensity.
- Depress push-button MAIN TB of delayed time-base trigger source selector.
- Put the delayed time-base TIME/DIV switch in the 5 μ s/DIV position.
- Adjust the LED-display to 0,0 –6.

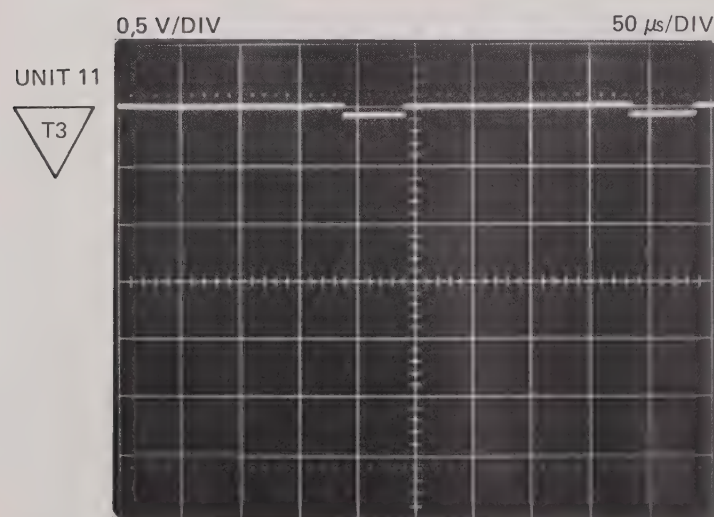


measuring oscilloscope:

- Triggering on signal on test point T1 of unit 11.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- Adjust the LED-display to 180,0 –6.

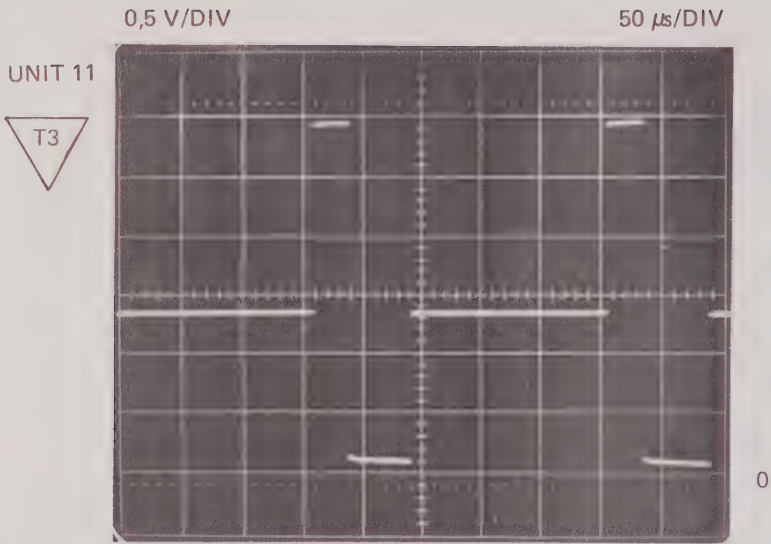


measuring oscilloscope:

- Triggering on signal on test point T3 of unit 11.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- Adjust the LED-display to 0,0 –6.

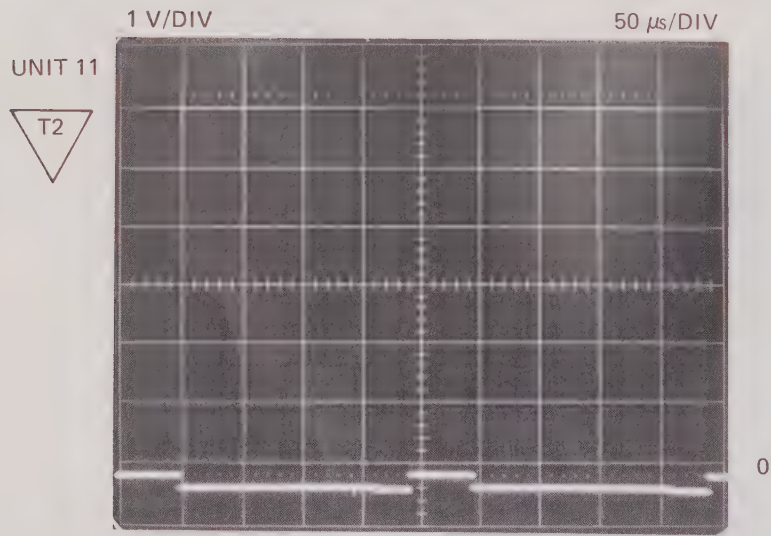


measuring oscilloscope:

- Triggering on signal on test point T3 of unit 11.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- Adjust the intensity control to maximal intensity.

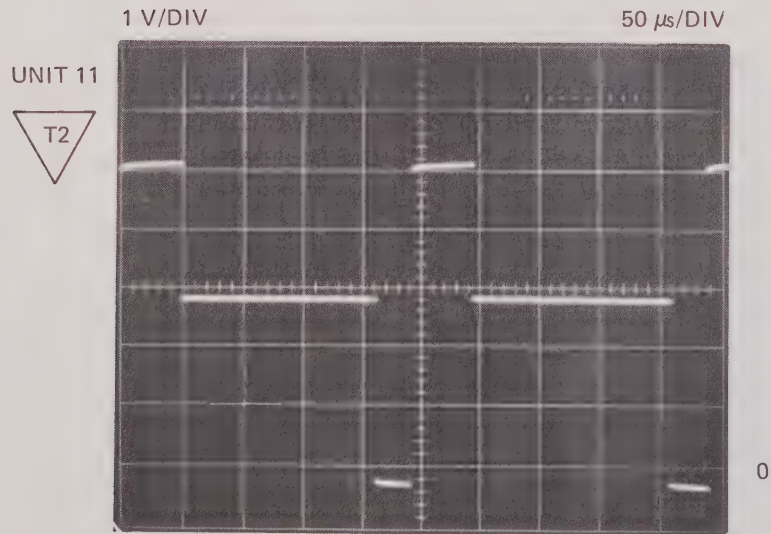


measuring oscilloscope:

- Triggering on signal on test point T2 of unit 11.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- Adjust the intensity control to minimal intensity.



measuring oscilloscope:

- Triggering on signal on test point T2 of unit 11.
- DC signal coupling.

oscilloscope under test:

- No input signal.
- Adjust the intensity control to maximal intensity.

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY **ASSESSMENT OF T & M INSTRUMENTS** (excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

①	②	③	④	
<i>Country</i>	<i>Day Month Year</i>	<i>Typenumber</i>	<i>/Version</i>	<i>Factory/Serial no.</i>
<table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">3</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">2</table>	<table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">1</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">5</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">4</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">7</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">5</table>	<table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">P</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">M</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">3</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">2</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">6</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">2</table>	<table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">D</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">O</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">7</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">8</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">3</table>	
CODÉD FAILURE DESCRIPTION				⑥
⑤	⑥	⑦	⑧	
<i>Nature of call</i>	<i>Location</i>	<i>Component/sequence no.</i>	<i>Category</i>	
<table border="1" style="display: inline-table; width: 20px; height: 20px; text-align: center;"> ☐ </table>	<table border="1" style="display: inline-table; width: 40px; height: 20px;"></table>	<table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">T</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">S</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">6</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">7</table>	<table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">5</table>	⑦ <i>Job completed</i> ☒
<table border="1" style="display: inline-table; width: 20px; height: 20px; text-align: center;"> ☐ </table>	<table border="1" style="display: inline-table; width: 40px; height: 20px;"></table>	<table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">R</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">6</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">3</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">1</table>	<table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">2</table>	
<table border="1" style="display: inline-table; width: 20px; height: 20px; text-align: center;"> ☐ </table>	<table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">2</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">1</table>	<table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">9</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">9</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">0</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">1</table>	<table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">4</table>	
<table border="1" style="display: inline-table; width: 20px; height: 20px; text-align: center;"> ☒ </table>	<table border="1" style="display: inline-table; width: 40px; height: 20px;"></table>	<table border="1" style="display: inline-table; width: 40px; height: 20px;"></table>	<table border="1" style="display: inline-table; width: 40px; height: 20px;"></table>	
<table border="1" style="display: inline-table; width: 20px; height: 20px; text-align: center;"> ☐ </table>	<table border="1" style="display: inline-table; width: 40px; height: 20px;"></table>	<table border="1" style="display: inline-table; width: 40px; height: 20px;"></table>	<table border="1" style="display: inline-table; width: 40px; height: 20px;"></table>	
<table border="1" style="display: inline-table; width: 20px; height: 20px; text-align: center;"> ☐ </table>	<table border="1" style="display: inline-table; width: 40px; height: 20px;"></table>	<table border="1" style="display: inline-table; width: 40px; height: 20px;"></table>	<table border="1" style="display: inline-table; width: 40px; height: 20px;"></table>	⑧ <i>Working time</i> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">1</table> <table border="1" style="display: inline-table; width: 40px; height: 20px; text-align: center;">2</table> Hrs

Detailed description of the information to be entered in the various boxes:

①Country:

 = Switzerland

②Day Month Year

 = 15 April 1975

③Type number/Version

 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number

 = DO 783 These data are mentioned on the type plate of the instrument

⑤ Nature of call: Enter a cross in the relevant box

⑥ Coded failure description

<i>Location</i> <table border="1" style="display: inline-table; width: 80px; height: 20px;"></table>	<i>Component/sequence no.</i> <table border="1" style="display: inline-table; width: 80px; height: 20px;"></table>	<i>Category</i> <table border="1" style="display: inline-table; width: 40px; height: 20px;"></table>
These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual). Example: 0001 for Unit 1 000A for Unit A 0075 for item 75 If units are not numbered, do not fill in the four boxes; see Example Job sheet.	These six boxes are intended to pinpoint the faulty component. A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric, the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes. B. Parts not identified in the circuit diagram: 990000 Unknown/Not applicable 990001 Cabine* r rack (text plate, emblem, grip, rail, graticule, etc.) 990002 Knob (incl. dial knob, cap, etc.) 990003 Probe (only if attached to instrument) 990004 Leads and associated plugs 990005 Holder (valve, transistor, fuse, board, etc.) 990006 Complete unit (p.w. board, h.t. unit, etc.) 990007 Accessory (only those without type number) 990008 Documentation (manual, supplement, etc.) 990009 Foreign object 990099 Miscellaneous	0 Unknown, not applicable (fault not present, intermittent or disappeared) 1 Software error 2 Readjustment 3 Electrical repair (wiring, solder joint, etc.) 4 Mechanical repair (polishing, filing, remachining, etc.) 5 Replacement (of transistor, resistor, etc.) 6 Cleaning and/or lubrication 7 Operator error 8 Missing items (on pre-sale test) 9 Environmental requirements are not met

⑦ Job completed: Enter a cross when the job has been completed.

⑧ Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

= 1,2 working hours (1 h 12 min.)

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Positive feedback

Now you are the user of a Philips test and measuring instrument. We trust that it will give you many years of faithful service. But we would like you to realize one thing: we can only supply the best in T & M equipment with **your** help, user.

We need to know what you have found to be the strong and weak points of this instrument; and we would be very interested to hear about any unusual or elegant applications you have devised for it. Some of this information can be passed on to our design and development departments; and some may be fed back to other users via our bimonthly publication **T & M News**.

May we therefore suggest that you fill in the reply card alongside and send it back to us right now. That way, you'll be helping to provide the positive feedback we need to help you!

All contributions that are published will be paid for at current rates; while as an inducement for you to fill in the reply card, we are offering a free subscription to T & M News or a free copy of Part I of our Digital Instrument Course to all who reply.

Erfahrungsaustausch

Meßgeräte müssen sich in der Praxis bewähren und die in sie gesteckten Erwartungen erfüllen; auch bei Ihnen, dem Besitzer eines Geräts aus der Serie der Philips Test- und Meßgeräte. Wir aber können T & M-Geräte nur zu Ihrer vollen Zufriedenheit herstellen, wenn wir alle Ihre Wünsche kennen.

Deshalb interessiert uns Ihre Meinung über die guten und weniger guten Eigenschaften dieses Gerätes. Außerdem suchen wir Erfahrungen über ungewöhnliche oder neue Anwendungsmöglichkeiten. Vielleicht können Sie unseren Entwicklungs- und Konstruktionsabteilungen einen guten Wink geben; vielleicht können wir Ihre Erfahrungen aber auch in unserer Publikation **Info-dienst** (nur in Deutschland) veröffentlichen, damit auch andere Anwender davon profitieren können.

Deshalb möchten wir Sie bitten, die anhängende Antwortkarte auszufüllen und an uns zurückzusenden. Damit helfen Sie uns, und wir können Ihnen helfen!

Alle veröffentlichten Beiträge werden dem üblichen Tariff entsprechend honoriert. Als Dank für das Ausfüllen der Antwortkarte bieten wir Ihnen ein Freiabonnenment auf Info-dienst (nur in Deutschland) oder ein kostenloses Exemplar von Teil I von unserem Kursus Digital Instrument.

L'intérêt du "feedback"

Vous voilà possesseur d'un instrument d'essai et de mesure Philips. Nous espérons qu'il vous donnera de nombreuses années de bons et loyaux services, mais nous voudrions attirer votre attention sur un point: ce n'est qu'avec **votre** aide que nous pouvons fournir des matériels d'essai et de mesure de toute première qualité.

Nous avons besoin de savoir quels en sont les points forts et les points faibles que vous avez découverts et nous serions très intéressés d'apprendre quelles applications inhabituelles ou élégantes vous lui avez trouvé. Certains de ces renseignements peuvent être transmis utilement à nos bureaux d'études; certains autres peuvent être communiqués à d'autres utilisateurs par l'intermédiaire de notre publication **T & M Informations** (édition française seulement en France).

C'est pourquoi nous vous serions reconnaissants de remplir la carte-réponse à côté et de nous la renvoyer. De cette façon, vous contribuerez à nous fournir le "feedback" dont nous avons besoin pour mieux vous servir!

Toutes les réponses publiées seront payées conformément aux tarifs en vigueur; pour vous inciter à remplir la carte-réponse, nous offrons un abonnement gratuit à T & M Informations ou un exemplaire gratuit de la première partie de notre cours sur les instruments numériques à tous ceux qui répondront.

Details of user:	Persönliche Angaben:	Expéditeur:
Company/ Firma/Société		
Department/ Abteilung/Service		
Street/Straße/Rue		
Box/Postfach/Boîte Postale		
City/Stadt/Ville		
Country/Land/Pays		
Name/Name/Nom		
Phone/Telefon/Numéro de téléphone		

Details of instruments:	Gerätedaten:	Instrument:
Name/Name/		
Désignation		
Type number/Typennummer/		
Numéro de type		
Serial number/Seriennummer/		
Numéro de série		
Date purchased/Kaufdatum/		
Date d'achat		

What are the main applications for which you use this instrument?
Wofür verwenden Sie dieses Gerät hauptsächlich?
Quelles sont les principales utilisations auxquelles vous affectez cet instrument?

Please, list what you consider to be the **strong points** and the **weak points** of the instrument. Zählen Sie bitte auf, was Ihrer Meinung nach die **guten Seiten** und was die **schwachen Stellen** dieses Geräts sind. Veuillez énumérer ce que vous considérez être les **points forts** et les **points faibles** de l'instrument.

Do you have any queries about the use of this instrument? If so, what?
Haben Sie irgendwelche Fragen über die Anwendung dieses Geräts? Wenn ja, welche?
Avez-vous des questions à poser sur l'emploi de l'instrument?
Si oui, lesquelles?

I have devised an interesting application for this instrument.
☐ I enclose a brief description (up to about 500 words) of this application
☐ Please send a representative to collect information about the application

Ich habe einen interessanten Verwendungszweck für dieses Gerät gefunden.
☐ Eine kurze Beschreibung hiervon (max. ca. 500 Wörter) erhalten Sie anliegend.
☐ Senden Sie bitte jemanden, der sich an Ort und Stelle über den Verwendungszweck informieren kann.

J'ai trouvé une application intéressante pour cet instrument
☐ Je joins une brève description (500 mots environ au maximum) de cette application.
☐ Veuillez envoyer un représentant à qui nous donnerons des renseignements sur l'application.

☐ I would like to receive **T & M News** regularly.
☐ Please send me Digital Instrument Course Part I.
☐ Ich möchte **Info-dienst** regelmäßig beziehen.
☐ Senden Sie mir Digital Instrument Course, Teil I.
☐ J'aimerais recevoir **T & M Informations** régulièrement.
☐ Envoyez moi la première partie du cours sur les instruments numériques.

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